Updated Status Review of Sicklefin and Sturgeon Chub in the United States

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UPDATED STATUS REVIEW OF SICKLEFIN AND STURGEON CHUB IN THE UNITED STATES

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I. SUMMARY

On August 8, 1994, the U.S. Fish and Wildlife Service (Service) received a formal petition to list the sicklefin chub (*Macrhybopsis meeki*) and the sturgeon chub (*Macrhybopsis gelida*) as endangered throughout their range pursuant to the Endangered Species Act (ESA) of 1973. The sicklefin and sturgeon chub are members of the Cyprinidae or minnow family and are endemic to the Missouri River basin and the Mississippi River below St. Louis in the central United States. Both of these species are highly adapted to living in free-flowing rivers with high levels of turbidity. The construction and operation of dams and reservoirs on the main stem Missouri River and channelization of the Middle and Lower Missouri River are the principal factors impacting sicklefin and sturgeon chub habitat by altering flow regimes, turbidity levels, and water temperature.

On January 19, 1995, the Service published a positive 90-day finding in the Federal Register that the petition and data available from other sources provided substantial information indicating that the petitioned action may be warranted. The Service requested comments on the 90-day finding; however, limited input was received. The Service also established a Status Assessment Team to gather information documenting sicklefin chub and sturgeon chub populations and determine whether listing these species as threatened or endangered under the ESA was warranted. A draft 12-month finding was completed in August 1995 and subsequently revised in 1997, 1999, and 2000 to include substantial new information. The Montana Rivers Coalition filed a 60-day notice of intent to sue the Secretary of the Department of the Interior on April 6, 2000, for the Service's failure to act on the petition in the time frames established by the ESA. The Montana Rivers Coalition's action resulted in a stipulated settlement agreement in which the Service agreed to submit the 12-month finding for the sicklefin and sturgeon chub for publication in the Federal Register on or before April 12, 2001.

The Service has received information concerning the status of sicklefin and sturgeon chub populations from State game and fish departments, the U.S. Bureau of Reclamation (Reclamation), U.S. Geological Survey, tribal representatives, universities, and other organizations and individuals.

The Service also reviewed information on the sicklefin and sturgeon chub from journal articles, agency reports and file documents, telephone interviews, and written correspondence with fisheries biologists familiar with these species.

The Service found that historic collection data documenting sicklefin and sturgeon chub populations are limited and provide an incomplete picture of their range and population levels. Both species have received little attention from fishery biologists until recent years.

The sicklefin chub was historically found in the Yellowstone River, Missouri River, and Mississippi River downstream from the confluence with the Missouri River. Construction of the six Missouri River main stem dams by the U.S. Army Corps of Engineers (Corps) between 1937

and 1964 eliminated sicklefin chub populations in the 800 miles of river converted to reservoir habitat and in approximately 200 miles of free-flowing reaches located below Garrison, Oahe, Big Bend, and Fort Randall Dams. The Service estimates that the sicklefin chub currently occupies approximately 54 percent of its historic range in the Missouri River basin. Field studies indicate that self-sustaining populations of sicklefin chubs occur in three reaches of the Missouri River--above the headwaters of Fort Peck Reservoir in Montana, in the Yellowstone - Missouri River confluence area of Montana and North Dakota, and in the Missouri River from St. Joseph, Missouri, to the confluence with the Mississippi River. Data collected by the Missouri Department of Conservation since 1997 indicate that a viable population of sicklefin chub are present in the Middle Mississippi River and in the Wolf Island area (river mile 930.7 to 935.0) of the Lower Mississippi River.

Sturgeon chub have been collected at or near the same locations where sicklefin chub populations have been documented in the Yellowstone, Missouri, and Mississippi Rivers. Sturgeon chub also have been historically collected in 30 of the larger tributaries to the Yellowstone and Missouri Rivers. Construction and operation of the six Missouri River main stem dams by the Corps has effectively isolated sturgeon chub populations. The sturgeon chub, like the sicklefin chub, has been extirpated from approximately 800 miles of the Missouri River that has been converted to reservoir habitat and from the 200 miles of free-flowing reaches below Garrison Dam in North Dakota and Oahe, Big Bend, and Fort Randall Dams in South Dakota. Operation of the Missouri River main stem dams continues to impact the chubs. The Service estimates that sturgeon chub currently occupy about 1,155 miles or about 55 percent of its former range in the Missouri River. Data available from fishery investigations conducted since 1994 indicate that viable populations of sturgeon chub are present in three reaches of the Missouri River--above the headwaters of Fort Peck Reservoir in Montana, upstream from Lake Sakakawea in North Dakota and Montana, and in the Missouri River in Missouri. A self-sustaining population of sturgeon chub also is present in the Lower Yellowstone River, the Middle Mississippi River, and in the Wolf Island area of the Lower Mississippi River.

Sturgeon chub populations are currently present in 11 of the 30 tributaries to the Yellowstone and Missouri Rivers where they were historically collected. Factors that have affected sturgeon chubs in the tributaries include construction and operation of dams and reservoirs, water withdrawals primarily for irrigation, and potential water quality impacts associated with energy production and intensive agriculture.

II. LIFE HISTORY AND ECOLOGY OF THE SICKLEFIN CHUB AND THE STURGEON CHUB

The sicklefin chub and sturgeon chub belong to the same genus of fishes (*Macrhybopsis*) in the minnow family (Cyprinidae). In general, they have similar distribution, habitat requirements, and are subject to similar threats. Therefore, they are addressed together in this updated status report.

Taxonomy

The sicklefin chub was first collected from the Missouri River near St. Joseph, Missouri, by Jordan and Meek (1885), but was initially misidentified as a sturgeon chub. Type specimens originated from later collections of Jordan and Evermann (1896) made at the same general area of the Missouri River near St. Joseph, Missouri, and were identified as *Hybopsis meeki*. The sicklefin chub was subsequently placed in the genus *Macrhybopsis* (Mayden 1989).

The sturgeon chub was first collected from the Milk River, a tributary to the Missouri River in Montana, during the Pacific Railroad Surveys of 1853-1855 by Dr. George Suckley (Girard 1856). Jordan and Gilbert (1882) first described the species as *Ceratichthys gelidus*. However, the generic name has been revised several times from *Ceratichthys* to *Hybopsis* (Jordan and Evermann 1896), to *Macrhybopsis* (Cockerell and Allison 1909, Jordan 1920), back to *Hybopsis* (Bailey 1951), and finally back to *Macrhybopsis* (Mayden 1989).

Morphology

The sicklefin chub is usually yellowish or tan colored on the back and silvery-white on the belly. The snout protrudes slightly beyond the mouth. The eyes are reduced and can be partially covered with skin. External taste buds are abundant on the underside of the head, lower body, and pectoral fins. The sicklefin chub also has a single pair of maxillary barbels located at the corner of the mouth. Sicklefin chub have extremely long pectoral fins and a deeply forked caudal fin with a darker lower lobe. The dorsal fin is sickle-shaped. Average adult length ranges from 35 to 100 millimeters (mm) (1.4 to 4.0 inches (in)) and average adult weight ranges from 0.5 to 6.0 grams (g) (0.02 to 0.2 ounce (oz)) (Cross 1967, Eddy and Hodson 1982). The sicklefin chub has a life-span of up to 4 years.

The sturgeon chub is tan to pale green on the back and cream to white on the belly. A few black speckles occasionally are present on the sides and back. It has a long, fleshy snout and subterminal mouth, in which a single pair of maxillary barbels are located at the corners. It has reduced eyes, a streamlined body, a deeply forked caudal fin, and epidermal keels on most scales. Taste buds are abundant on the underside of the head and on the belly and fins. These morphological features are adaptations to life in swift, turbid stream environments (Cross 1967, Pflieger 1975). Average adult length ranges from 35 to 95 mm (1.5 to 3.8 in) and average adult weight ranges from 0.3 to 7.3 g (0.01 to 0.3 oz) (Branson 1963, Branson 1966, Cross 1967, Reno 1969, Eddy and Underhill 1978, Robison and Buchanan 1988, and Werdon 1992). The sturgeon chub is a relatively short-lived species with a life-span of up to 4 years.

Both species are similar in morphology, but they possess distinct morphological characteristics. A unique characteristic of the sturgeon chub is its longitudinally-arranged epidermal keels, which improve hydrodynamic efficiency (Cross 1967). The unique characteristics of the sicklefin chub are the elongated pectoral fins and a sickle-shaped dorsal fin.

Habitat

General habitat requirements for the sturgeon chub and sicklefin chub have been reported by Cross (1967), Pflieger (1975), and the Service (U.S. Fish and Wildlife Service 1993a, 1993b). The sicklefin chub and sturgeon chub evolved in large, free-flowing riverine systems, characterized by swift flows, highly variable flow regimes, braided channels, high turbidity, and sand/fine gravel substrates. Both species generally use similar macrohabitat types and have similar biological requirements.

Studies conducted in the 1990s in Montana (Grisak 1996), North Dakota (Everett 1999), and Missouri (Grady and Milligan 1998) have described habitat characteristics at sicklefin chub collection sites. Sicklefin chubs were collected at depths from 0.1 to 11.0 meters (m) (0.3 to 36 feet (ft), bottom velocities from 0.14 to 1.06 m (0.5 to 3.5 ft) per second, and over a variety of substrate types. While sicklefin chubs have been collected from almost every type of Missouri River habitat type at one time, most fish have been collected in main channel, border channel, and sandbar macrohabitats over sand and fine gravel substrate.

Dieterman (2000) statistically examined 67 variables believed to influence sicklefin chub distribution in the Missouri River, including physical habitat, water quality, flow regime, and predation. This study presented the first quantitative evaluation between sicklefin chub distribution patterns and large-scale Missouri River features. Dieterman found four variables were significant following correction for multiple tests--distance to upstream impoundment, flow constancy, mean segment turbidity, and percent of annual flow in August. Occurrence of sicklefin chub was highest when a segment of the Missouri River was greater than 187 miles (301 km) downstream from a dam; flow constancy was 0.56 or less, indicating an association with river segments having more variable flow regimes; mean summer-early fall turbidity levels were 80 NTUs or greater; and the percent of flow in August was low, less than 10 percent of the total annual flow.

Dieterman (2000) also evaluated habitat use by age-0 and age-1+ sicklefin chub. Three site scale variables differed significantly between juvenile and adult sicklefin chub following correction for multiple tests. Sites where age-1+ sicklefin chub were present were characterized by faster water column velocities, a higher percentage of gravel, and a lower percentage of silt than sites where age-0 fish were collected. Optimum habitat conditions for adult sicklefin chub were analyzed using two methods. The Peeters and Gardeniers (1998) method indicated that optimum conditions during the summer-early fall ranged from 2.20 to 4.80 m (7.2 to 15.7 ft) for depth and 0.6 to 1.10 m (2.0 to 3.6 ft) per second for velocity. Wider optimum habitat conditions were predicted using the Jongman et al. (1987) method, with optimum depth ranging from 1.72 to 5.21 m (5.6 to17.1 ft) and velocity from 0.54 to 1.16 m (1.7 to 3.8 ft) per second.

The majority of sicklefin chub collected by Grisak (1996), Everett (1999), and Hrabik and Herzog (in litt. 2000a) were found over sand substrate. Dieterman (2000) statistically found a significant positive association of age-1+ sicklefin chub with gravel substrates. Grady and

Milligan (1998) collected the greatest percentage of sicklefin chub over organic matter (46.7 percent) and silt (23 percent). Most of these fish were likely age-0 fish. Sturgeon chub also are usually found in main channel and channel border habitats in areas with gravel and/or sand substrate with greatest abundance with fine to medium gravel.

Sturgeon chub and sicklefin chub are often captured together in the Yellowstone, Missouri, and Mississippi Rivers. Welker (2000) collected sturgeon chub in a wide range of depths and current velocities in the Yellowstone/Missouri River confluence area in North Dakota. The highest percentage of sturgeon chub were captured in depths from 2 to 5 m (88 percent) (6.6 to 16.4 ft) and in current velocities from 0.5 to 1.0 m (1.6 to 3.3 ft) per second (81 percent). Most studies describing sturgeon chub collection sites (Reigh and Elsen 1979, Gould 1994, Gelwicks 1996, and Hrabik and Herzog in litt. 2000a) indicate that the primary substrate used by sturgeon chubs is gravel. Welker (2000) reported that sturgeon chub in the Yellowstone/Missouri River confluence area primarily used sand substrate; however, he noted an increasing percent of gravel at sites positively influenced sturgeon chub densities.

In contrast to sicklefin chub, which only occur in large river systems, sturgeon chub also inhabit tributaries to the Yellowstone and Missouri Rivers. Trenka (2000) sampled sturgeon chub in the Montana reach of the Powder River in 1997 and 1998. Nearly all of the 61 sturgeon chub he collected (98.3 percent) were found in bar, inside bend, and secondary channel habitats. Sturgeon chub were primarily collected in shallow water areas, with moderately swift currents. Two-thirds (66.7 percent) of the sturgeon chub taken in seine hauls were from depths between 0.2 to 0.39 m (0.7 to 1.3 ft), and 75 percent were in areas with a current velocity between 0.4 to 0.79 m (1.3 to 2.6 ft) per second. Reigh and Elsen (1979) collected sturgeon chub at 41 sites in the Little Missouri River and 3 sites in the Yellowstone River in North Dakota in 1976 and 1977. Approximately, 93 percent of the sturgeon chub collected were in areas with rock and gravel substrate with moderate current.

Age and Growth

Grisak (1996) summarized age/length relationships for sicklefin chub collected in the Missouri River above Fort Peck Reservoir, Montana, in 1994 and 1995 (Table 1). The oldest fish he collected was age 4. Sicklefin chub collected during this study weighed between 0.6 and 9.6 g (0.02 and 0.34 oz). The heaviest male and female weighed 6.0 and 9.6 g (0.21 and 0.34 oz), respectively. Most specimens weighed between 1 and 6 g (0.03 and 0.34 oz).

Table 1. Length Range by Age Class of Sicklefin Chub Collected in the Missouri River Above Fort Peck Reservoir, Montana, 1994-1995.

Age	Length Range (mm)	Percent of Sampled Population
1	29 - 42 (1.1 - 1.6 in)	29
2	43 - 75 (1.7 - 2.9 in)	33
3	73 - 93 (2.9 - 3.7 in)	34
4	95 - 109 (3.7 - 4.3 in)	4

Everett (1999) evaluated age and growth relation for sicklefin and sturgeon chub collected in the Lower Yellowstone and Missouri Rivers in North Dakota (Tables 2 and 3). The oldest sicklefin and sturgeon chub collected were age 4 and 3, respectively. Stewart (1981) collected one sturgeon chub specimen that was age 4+ from the Powder River in Wyoming.

Table 2. Sicklefin Chub Age and Growth Relationships for Fish Collected in the Lower Yellowstone and Missouri Rivers in North Dakota, 1995.

Age	Length Range (mm)	Weight Range (g)	Percent of Sampled Population
1	39 - 53 (1.5 - 2.1 in)	0.7 - 1.1 (0.02 - 0.04 oz)	5
2	53 - 85 (2.1 - 3.3 in)	0.8 - 4.2 (0.03 - 0.15 oz)	70
3	86 - 99 (3.4 - 3.9 in)	3.3 - 7.7 (0.12 - 0.27 oz)	22
4	107 (4.2 in)	10.1 (0.36 oz)	2

Table 3. Sturgeon Chub Age and Growth Relationships for Fish Collected in the Lower Yellowstone and Missouri Rivers in North Dakota, 1995.

Age	Length Range (mm)	Weight Range (g)	Percent of Sampled Population
1	35 - 50 (1.4 - 2.0 in)	0.6 - 0.9 (0.02 - 0.03 oz)	6
2	51 - 75 (2.0 - 2.8 in)	0.7 - 2.1 (0.02 - 0.07 oz)	68
3	73 - 86 (2.9 - 3.4 in)	1.9 - 6.7 (0.07 - 0.24 oz)	26

Reproduction

The reproductive biology of sicklefin and sturgeon chub is largely unknown. Spawning is believed to occur in the spring as Pflieger (1975) collected young-of-the-year in July from the Missouri River in the State of Missouri. Werdon (1993 a,b) speculated that spawning is likely influenced by water temperature and also may be affected by increasing flows due to snowmelt or precipitation events. Larval *Macrhybopsis* chubs, including either or both sicklefin and sturgeon chubs, were collected in 1996 (Tibbs and Galat 1997). Water temperatures during spawning were estimated based on larval fish development to range from 20.5 to 26.2° C (68.9 to 79.2° F), with peak spawning temperatures ranging from 20.5 to 25.3° C (68.9 to 77.5° F) (Dieterman 2000). Sturgeon chub females in the Powder River in Wyoming became ripe in early June, with the principal spawning activity occurring later in the month and into July (Stewart 1981). Stewart collected no gravid females after July 26 and reported that scales taken from gravid females suggest sexual maturity at age 2+.

While additional research is needed to document the reproductive biology of sicklefin and sturgeon chub, sampling since 1994 indicates that there are stable, self-sustaining populations in widely scattered areas throughout their range. Chub populations are successfully reproducing under a variety of climatic conditions and subsequent flow regimes within the Missouri River Basin and Mississippi River.

Feeding Habits

Almost no information documenting the feeding habits of sicklefin and sturgeon chub has been published. Reigh and Elsen (1979) reported that three sicklefin chubs collected near the mouth of the Yellowstone River in North Dakota contained one black fly pupa (*Simulium* sp.) and pieces of what appeared to be insect exoskeletons, among other unrecognizable material. They also reported that sturgeon chub collected from the Little Missouri River in North Dakota contained insect body parts, but no other identifiable material. Stewart (1981) examined the stomach content of eight sturgeon chub collected from the Powder River in Wyoming. He found pieces of aquatic insects that could not be identified further.

III. HISTORICAL RANGE AND CURRENT DISTRIBUTION, GENERAL

Historical range of fish species is generally based on presence or absence of reliable catch records in peer-reviewed, published literature. Specific citations for field studies documenting sicklefin chub and sturgeon chub populations and experts' opinion on distribution and range are provided in subsequent sections of this report addressing specific river reaches.

In general, the historic record for the sicklefin chub and the sturgeon chub documents presence or absence and the total number of individuals collected. This record provides an incomplete picture of the range of these fish and their populations prior the constructions of dams and other water development activities that have impacted chub habitat. Historically, studies designed to

document fish populations primarily focused on sport fish, with limited attention given to native cyprinid populations in the Missouri and Mississippi River basins. No long-term research has been conducted to estimate the size of sicklefin and sturgeon chub populations or determine how chub populations have changed over time.

In 1993, the historical capture data for the sicklefin and sturgeon chub were documented in two status reports prepared by the Service (U.S. Fish and Wildlife Service 1993a, 1993b). This work, combined with the 1994 petition to list the sicklefin and sturgeon chub as endangered, has resulted in an additional emphasis being placed on sampling native cyprinid populations.

Since 1994, when the Service was petitioned to list the sicklefin chub and the sturgeon chub as endangered, a number of field studies have been conducted to sample chub populations. Data available from recent field investigations provide a more complete record of the locations where sicklefin and sturgeon chub occur. Fisheries biologists also have improved the techniques for collecting chubs. Historically, seines of various lengths were used to sample cyprinid populations in shallow water habitat. Since 1994, researchers have found that benthic trawling is a more effective method of collecting sicklefin and sturgeon chub, particularly in water depths over 1 meter. Recent studies using benthic trawls indicate that sicklefin chub and sturgeon chub are more abundant and more widely distributed than indicated in the 1993 status reports, including areas in Montana, North Dakota, South Dakota, Nebraska, and Missouri.

Historically, the sicklefin chub was collected in the Yellowstone River in Montana and North Dakota, the Missouri River from Montana to its confluence with the Mississippi River near St. Louis, and the Mississippi River downstream from the mouth of the Missouri River. Sicklefin chubs also have been collected rarely in the Lower Kansas River in the year following high flows in the Missouri River. Based on reliable catch records, the sicklefin chub historically occurred in the waters bordering or within the following 13 States--Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Missouri, Illinois, Kentucky, Tennessee, Arkansas, Louisiana, and Mississippi. Data from the existing catch records and information available from fisheries biologists have been used to estimate the historic and current distribution of sicklefin chub. Please see Maps 1 and 2 and Tables 4 and 5.

Sicklefin chub habitat was substantially altered by the construction and continuing operation of six multipurpose dams and reservoirs on the Missouri River and channelization of the Lower Missouri River by the Corps. The Missouri River dam and reservoirs were completed between 1937 and 1964 as part of the Pick-Sloan Plan, a multi-purpose flood control and water development project implemented by the Corps and Reclamation. Today, on the main stem Missouri River, approximately 36 percent of the habitat within the range of sicklefin chub has been transformed into reservoir habitat, another 40 percent downstream of the dams has been channelized, and 24 percent of the river habitat has been altered by flow modifications, hypolimnetic releases, and reduced turbidity levels.

Click to View Map 1 - Sicklefin Chub Historical Range (Missouri River Basin)

Click to View Map 2 - Sicklefin Chub Current Range (Missouri River Basin)

Impacts to sicklefin chub populations from reservoir operations and channelization varies. Recent studies conducted in Montana, North Dakota, and Missouri using benthic trawls indicate that sicklefin chub comprise a significant portion of the fish population above Fort Peck Reservoir in Montana, in the Yellowstone/Missouri River confluence area of North Dakota and Montana, and in the channelized reach of the Missouri River in Missouri. At the opposite end of the spectrum, sicklefin chub populations have been extirpated from approximately 800 miles of riverine reaches that have been converted to reservoir habitat and approximately 200 miles of free-flowing reaches below Garrison Dam in North Dakota and Oahe, Big Bend, and Fort Randall Dams in South Dakota. The Service estimates that sicklefin chub currently occupy 54 percent of their historic range in the Missouri River basin.

Sicklefin chub populations also are present in the Middle and Lower Mississippi River. Field work conducted since 1997 by the Missouri Department of Conservation's Open River Field Station (this research center also is known as the Long Term Research Monitoring Station) has provided new information documenting both sicklefin and sturgeon chub populations in this portion of their range. Sicklefin chub habitat in the Middle and Lower Mississippi River has been altered by the construction of dike fields, bendway weirs, and other structures designed to maintain the navigation channel. However, due to the limited number of studies documenting sicklefin chub populations in the Mississippi River, the importance of this population and the full extent of impacts are unknown.

Sturgeon chub have been collected at or near the same locations where sicklefin chub populations have been documented in the Yellowstone, Missouri, and Mississippi Rivers. Sturgeon chub also have been collected historically in a number of the larger tributaries to the Yellowstone and Missouri Rivers. Based on reliable catch records, sturgeon chub have been collected in waters bordering or within the same 13-State range as the sicklefin chub, plus the Powder River drainage in Wyoming and Montana. Table 6 lists the tributaries to the Yellowstone and Missouri Rivers where sturgeon chub populations occur and the tributaries where sturgeon chub populations are believed to be extirpated. Information documenting the extent of the sturgeon chub's historic range in most tributaries is not available. Maps 3 and 4 present a pictural estimate of the historic and current distribution of sturgeon chub.

Construction and operation of the six Missouri River main stem dams and channelization of the Lower Missouri River by the Corps have substantially altered sturgeon chub habitat. Like sicklefin chub, impacts to sturgeon chub from reservoir operation and channelization varies. Fisheries studies conducted since 1994 using benthic trawls indicate sturgeon chub comprise a significant portion of the fish population in the Missouri River above Ft. Peck Reservoir, in the Yellowstone/Missouri River confluence area of North Dakota and Montana, and in Missouri. The sturgeon chub has been extirpated from approximately 800 miles of the Missouri River that has been converted to reservoir habitat and in the 200 miles of free-flowing reaches below Garrison Dam in North Dakota and Oahe, Big Bend, and Fort Randall Dams in South Dakota. Based on the best available survey data, the Service estimates that sturgeon chub currently occupy about 1,155 miles or 55 percent of its historical range in the Missouri River. Viable, self-sustaining populations of sturgeon chub also are found in the Lower Yellowstone River.

Table 4. Estimated Historic Distribution of Sicklefin Chub Populations in the Missouri and Mississippi River Basins.

	RIVER MILES
MISSOURI RIVER BASIN	
MISSOURI RIVER	
Mouth of Cow Creek, Montana, to the Confluence with the Mississippi River	**1,950**
YELLOWSTONE RIVER	
Mouth of Thirteen Mile Creek to the Confluence with the Missouri River	**85**
TOTAL	**2,035**
MISSISSIPPI RIVER BASIN	
MIDDLE MISSISSIPPI RIVER	
Mouth of the Missouri River to the Confluence with the Ohio River	**195**
LOWER MISSISSIPPI RIVER	
Mouth of the Ohio River to the Gulf of Mexico	**955**
TOTAL	**1,150**

Table 5. Estimated Current Distribution of Sicklefin Chub Populations in the Missouri and Mississippi River Basins.

	RIVER MILES
MISSOURI RIVER BASIN	
MONTANA	
Missouri River	
Cow Creek to Headwaters of Fort Peck Reservoir	**61**
Fort Peck Dam to North Dakota Border	**110**
Yellowstone River	
Thirteen Mile Creek to North Dakota Border	**68**
NORTH DAKOTA	
Missouri River	
Montana Border to Headwaters of Lake Sakakawea	**34**
Yellowstone River	
Montana Border to the Missouri River	**17**
SOUTH DAKOTA - MISSOURI	
Missouri River	
Gavins Point Dam to St. Joseph Missouri[1]	**370**
MISSOURI	
Missouri River	
St. Joseph, Misosuri, to the Mississippi River	**440**
TOTAL	**1,100**
MISSISSIPPI RIVER BASIN	
MISSOURI - ILLINOIS	
Middle Mississippi River	
Mouth of the Missouri River to the Confluence with the Ohio River	**195**
MISSOURI - LOUISIANA	
Lower Mississippi River	
Mouth of the Ohio River to the Gulf of Mexico[2]	**955**
TOTAL	**1,150**

The Missouri Department of Conservation's Open River Field Station has provided new

[1] Sicklefin chub occur in low numbers.

[2] Limited information available documenting the sicklefin chub populations.

information documenting both sicklefin and sturgeon chub populations in the Middle and Lower Mississippi River. Sturgeon chub habitat in the Middle and Lower Mississippi River has been altered by the construction of dike fields, bendway weirs, and other structures designed to maintain the navigation channel. However, due to the lack of data documenting sicklefin chub populations in the Mississippi River the importance of this population and the full extent of impacts are unknown.

Sturgeon chub populations are likely extirpated from 19 of 30 tributaries to the Yellowstone and Missouri Rivers.

IV. HISTORICAL RANGE AND CURRENT DISTRIBUTION

UPPER MISSOURI RIVER BASIN

The Upper Missouri River basin includes the main stem Missouri River system and tributaries within the basin from the headwaters in Montana downstream to the Gavins Point Dam (river mile 811) in southeastern South Dakota. Six main stem Corps dams, reservoirs, and inter-reservoir reaches with regulated flows are located along the Upper Missouri River. This portion of the basin includes the tributary rivers and streams in Wyoming, Montana, North Dakota, and South Dakota.

Historically, the sicklefin chub in the Upper Missouri River basin was found in the main stem Missouri River from South Dakota to Montana and in the Lower Yellowstone River in Montana and North Dakota (U.S. Fish and Wildlife Service 1993a). The range of sturgeon chub overlapped the range of the sicklefin chub. In addition, sturgeon chub distribution included 30 turbid tributaries in the Missouri River basin, including the Yellowstone River and several of its tributaries in Wyoming and Montana (U.S. Fish and Wildlife Service 1993b, Montana Department of Fish, Wildlife, and Parks in litt. 2000).

Wyoming: In Wyoming, the sturgeon chub was collected historically in the North Platte, Big Horn, and Powder River drainages. The sturgeon chub is extirpated from the North Platte and is thought to be gone from the Big Horn River, due to the construction of large impoundments and alterations to flow regimes and physical habitat (Mike Welker, Wyoming Game and Fish Department, pers. comm. 2000, and Bill Wilchers, Wyoming Game and Fish Department, in litt. 1997). Sturgeon chub were last collected from the Big Horn River in 1981. Several surveys have been conducted since 1981, including an extensive effort by the Wyoming Game and Fish Department in 2000; however, no sturgeon chub were captured (Mike Welker, pers. comm. 2000).

Click to View Map 3 - Sturgeon Chub Historical Range (Missouri River Basin)

Click to View Map 4 - Sturgeon Chub Current Range (Missouri River Basin)

Table 6. Historic and Current Distribution of Sturgeon Chub in Tributaries to the Yellowstone and Missouri Rivers.

YELLOWSTONE RIVER TRIBUTARIES

	EXTANT	EXTIRPATED
WYOMING	**1. Powder River** **2. Crazy Woman Creek**	**1. Big Horn River** **2. North Platte River**
MONTANA	**3. Tongue River** **Powder River** **4. Sears Creek** **5. Box Elder Creek**	**3. Sunday Creek** **Big Horn River**

MISSOURI RIVER TRIBUTARIES

MONTANA	**6. Redwater River**	**4. Milk River** **5. Teton River**
NORTH DAKOTA		**6. Little Missouri River** **7. Box Elder Creek** **8. Beaver Creek** **9. Green River** **10. Heart River**
SOUTH DAKOTA	**7. White River** **8. Little White River** **9. Bear in the Lodge Creek** **10. Cheyenne River**	**11. Grand River** **Little Missouri River**
NEBRASKA	**11. Platte River**	**12. Niobrara River** **13. Republican River** **14. Loup River** **15. Elkhorn River** **16. Bazile Creek**
KANSAS		**17. Smoky Hill River** **18. Kansas River** **19. Wakarusa River** **Republican River**

A survey of warmwater fishes in the Missouri River drainage in Wyoming (83 streams and 181 locations) was conducted during 1993-1995 (Patton 1997, Patton et al. 1998). Sturgeon chub were found at four locations on the Powder River and at one location on the lower reach of Crazy Woman Creek, a tributary of the Powder River. This survey extended the known range of the sturgeon chub up the Powder River by 50 mi. By comparing 1960s and 1990s survey data and adjusting the data for gear bias between surveys, Patton (1997) concluded the sturgeon chub population in Wyoming is stable, but limited in distribution.

Montana: Considerable data recently have become available on the current distribution of the sturgeon chub and sicklefin chub. The Benthic Fish Study for the Missouri River and Lower Yellowstone River, the largest fish study ever conducted on the Missouri River system, began in 1995. Standard sampling techniques and gears (e.g., gill nets, benthic trawls, bag seines, electroshocking, and trammel nets) were used during three field seasons in 1996-1998 and targeted bottom-dwelling benthic fish, including the sturgeon chub and sicklefin chub. The study, chiefly sponsored by the Corps, but supported by several other Federal agencies, was undertaken by a consortium of river scientists from six U.S. Geological Survey, Biological Resources Division, Cooperative Fish Research Units (Montana, Idaho, South Dakota, Iowa, Kansas, Missouri), and the Montana Department of Fish, Wildlife, and Parks.

Despite six low-head diversion dams for irrigation systems, the lower Yellowstone River appears to support a healthy population of sturgeon chub. Researchers with the Benthic Fish Study collected 230, 285, and 712 sturgeon chub, and 6, 34, and 53 sicklefin chub from the Yellowstone River in 1996, 1997, and 1998, respectively (Dieterman et al. 1997; Young et al. 1998; Mike Ruggles, Montana Department of Fish, Wildlife and Parks, in litt. 1999). These fish were collected from the 71-mile reach of Yellowstone River between the Intake Diversion Dam in Montana downstream to the confluence with the Missouri River in North Dakota.

During 1996-1998, Reclamation conducted investigations of the impacts of irrigation withdrawals and fish entrainment at the Intake Diversion Dam on the Lower Yellowstone River (Hiebert et al. 1999). The diversion is controlled through 11 inscreen sluice conduits. Estimates of fish entrainment were obtained by collecting all fish from 2 to 4 of the 11 conduits with fyke nets. During limited sampling using 2 conduits in 1996, a total of 2,931 fish were collected from the water diversion canal, including 378 sturgeon chub (12.9 percent). No sicklefin chub were collected that year. In 1997, Reclamation intensified the effort to 24 hours per day for 8 days and collected a total of 7,980 fish, including 1,008 sturgeon chub (12.7 percent), and 2 sicklefin chub. This extended the known range for the sicklefin chub upstream in the Yellowstone River. Entrainment netting in 1998 collected a total of 4,529 fish, including 744 sturgeon chub (16.5 percent), and 0 sicklefin chub. Estimates of total entrainment were determined by extrapolating the monthly average entrainment rates over the irrigation season. Hiebert (et al. 1999) projected that approximately 289,000 ± 113,000 sturgeon chub were entrained in the irrigation canal system.

Both the sturgeon chub and sicklefin chub are known to occur in the Missouri River above Fort Peck Reservoir (Grisak 1996). Grisak's field work highlights that different fishery collection methods can yield substantially different results. During the 1994-1995 field seasons, benthic trawls and bag seines were used in July and August to sample a 100-mile stretch of the Missouri River upstream from the headwaters of Fort Peck Reservoir (Grisak 1996). During 141 seine hauls at 23 random sites 5,095 fish were collected, including 4 sicklefin chub (0.08 percent of the catch) and 8 sturgeon chub (0.16 percent of the catch). Sturgeon chub and sicklefin chub ranked 14th and 15th in abundance, respectively. In contrast to the seine collection data, sicklefin and sturgeon chub were the second and third most common species collected in benthic trawl tows. During 1994 and 1995, Grisak collected 1,376 fish with a benthic trawl, including 302 sicklefin chub (21.9 percent of the catch) and 260 sturgeon chub (18.9 percent of the catch). The benthic trawl permitted collections at sites with deeper water. The mean depth at trawl sites where sicklefin chubs were collected was 3.41 m (11.2 ft) (1.37 to 6.41 m - 4.5 to 21.0 ft), as compared to an average depth of 0.50 m (1.6 ft) (0.19 to 0.86 m - 0.6 to 2.8 ft) at sites sampled with seines. Grisak did not collect sicklefin chub in the upper two segments of his study area (Judith River confluence - river mile 1982 to Grand Island - river mile 1930) where water depth generally does not exceed 2.4 m (7.9 ft). All sicklefin chub were collected in the lower three segments of the study area (Grand Island to the headwaters of Fort Peck Reservoir - river mile 1883). Maximum water depth ranged from 5.5 to 11.6 m (18 to 38 ft) in this area.

Data from the Benthic Fish Study indicate that 43, 161, and 377 sturgeon chub, and 21, 109, and 137 sicklefin chub were collected from a 70-mile reach of river immediately above Fort Peck Reservoir in 1996, 1997, and 1998, respectively (Dieterman et al. 1997; Young et al. 1998; Lee Berstedt, Montana Cooperative Fishery Research Unit, in litt. 1999). In general, sampling efforts increased in successive years and most chubs were caught with benthic trawls.

In recent years, Tews (1994), Liebelt (1996), Dieterman et al. (1997), Young et al. (1998), and Ruggles (in litt. 1999) reported distributional data for the sicklefin chub and sturgeon chub on the Missouri River segment between Ft. Peck Dam (river mile 1771) and the Yellowstone River (river mile 1582). Their collective data indicate that both species appear to be absent from the 11-mile segment of river from Fort Peck Dam downstream to the Milk River (river mile 1760). Recent fish surveys in the Milk River tributary by the Montana Department of Fish, Wildlife, and Parks in 1997 and 1998 did not document the presence of the sturgeon chub (Mike Ruggles, in litt. 1999).

Sturgeon chub are found in increasing numbers from the Milk River downstream to the Yellowstone River. During the 3-year period from 1996-1998, 5, 9, and 14 sturgeon chub were collected in the 59-mile Missouri River segment from the Milk River to Wolf Point (river mile 1701). Collections increased to 37, 48, and 40 sturgeon chub in the 199-mile Wolf Point to Yellowstone River segment of the Missouri River during the same time period (Dieterman et al. 1997; Young et al. 1998; Mike Ruggles, in litt. 1999).

In general, sicklefin chub are less numerous than sturgeon chub in the inter-reservoir reach between Fort Peck and Lake Sakakawea (river mile 1552). They were not found in the Milk River to Wolf Point segment. They are found in the Wolf Point to Yellowstone segment, but only in the lower reaches from the Redwater River confluence downstream. In 1996-1998, Benthic Fish Study researchers collected 6, 18, and 35 sicklefin chub from this reach of river (Dieterman et al. 1997; Young et al. 1998; Mike Ruggles, in litt. 1999).

The Montana Department of Fish, Wildlife, and Parks is conducting a study to evaluate the pallid sturgeon reintroduction program in the Missouri River above Fort Peck Reservoir. As part of this initiative, benthic trawl samples were collected in 1999 and 2000. In August of 1999, 308 benthic trawl tows yielded 561 sicklefin chub and 218 sturgeon chub. Sicklefin chub were the most common species collected, comprising 41.5 percent of the total catch, and sturgeon chub were the third most prevalent species, comprising 16.1 percent of the catch (Gardner 2000a). In August 2000, 145 sturgeon chub (32.0 percent of the catch) and 23 sicklefin chub (5.1 percent of the catch) were captured in 105 benthic trawl tows. Sturgeon chub and sicklefin chub were the second and third most common fish sampled by trawling in 2000 (Gardner 2000b).

Based on survey data collected during the past 24 years, the Montana Department of Fish, Wildlife, and Parks believes that the sturgeon chub and sicklefin chub are more widely distributed in Montana than previously described (Larry Peterman, Montana Department of Fish, Wildlife, and Parks, in litt. 1995; Patrick Graham, Montana Department of Fish, Wildlife, and Parks, in litt. 1997 and 2000). The Montana Department of Fish, Wildlife, and Parks summarized the records compiled in the Montana River Information System for sicklefin and sturgeon chub. Using collection records from 1977 to the present, sturgeon chub occur in 1,100 miles of streams in Montana, including the Missouri River and two tributaries (Redwater and Teton Rivers) and the Yellowstone River and four tributaries (Box Elder Creek, Powder River, Sears Creek, and Tongue River). Sicklefin chub populations, which were first documented in Montana in 1979, occur in 231 miles of the Yellowstone and Missouri Rivers. The Montana Department of Fish, Wildlife, and Parks also believes that researchers would increase their success in collection of these chub species by using trawling techniques and targeting different habitats.

North Dakota: With increased efforts in recent years to further document the distribution and abundance of the sturgeon chub and sicklefin chub, several researchers have surveyed the confluence area of the Yellowstone and Missouri Rivers in northwestern North Dakota since 1992 and documented populations of both species (Tews 1994; Welker 2000; Jason Lee, North Dakota Game and Fish Department, in litt. 1995; Greg Power, North Dakota Game and Fish Department, in litt. 1995 and 1997; Steve Krentz, U.S. Fish and Wildlife Service, pers. comm. 1995; Everett and Scarnecchia 1996; Liebelt 1996; Dieterman et al. 1997; Young et al. 1998; Mike Ruggles, in litt. 1999). Both species have been collected with benthic trawls and seines in the Lower Yellowstone River from the mouth upstream to the Montana border (river mile 0-14), as well as from the Missouri River from Lake Sakakawea upstream to the Montana border (river mile 1552-1585) (Welker 2000, Everett 1999)

During a pallid sturgeon study, Tews (1994) collected 47 sturgeon chub between river mile 2 and river mile 51 on the Yellowstone River by seining. Sturgeon chub were the second most common species collected by that method. In 1994, the North Dakota Game and Fish Department collected 30 sicklefin chub from the Missouri River west of Williston, North Dakota (Jason Lee, pers. comm. 1995).

In 1995, the University of Idaho and the North Dakota Game and Fish Department initiated a study to assess the distribution, relative abundance, and relative density of sturgeon chub and sicklefin chub along three segments of the Yellowstone and Missouri Rivers (Everett and Scarnecchia 1996). The study area included the Yellowstone River near its confluence with the Missouri River, and segments of the Missouri River near Williston and Bismarck, North Dakota. A total of 2,726 fish were collected using a benthic trawl and seine, including 64 sicklefin chub (2.3 percent) and 31 sturgeon chub (1.1 percent). No sicklefin or sturgeon chub were collected in the Bismarck segment. Both species were collected throughout 94 percent of the area sampled in the Williston and Yellowstone segments. Everett (1996) reported a substantial difference in the catch results produced by benthic trawl tows and seine hauls. Sicklefin chubs comprised 7.9 percent of the benthic trawl catch and 0.4 percent of the catch with seines. Sturgeon chub showed a similar pattern, comprising 3.2 percent of the benthic trawl catch and 0.4 percent of the fish collected by seining. Over 60 percent of the sicklefin and sturgeon chub sampled by Everett were collected from the main channel in water depths where seines are not usable. The mean depth at sicklefin and sturgeon chub collection sites was 6.8 and 2.5 meters, respectively. Sicklefin and sturgeon chub were the second and third most common cyprinids, respectively, from the Williston and Yellowstone study areas.

During the Benthic Fish Study in 1996-1998, 11, 16, and 1 sturgeon chub, and 28, 7, and 21 sicklefin chub were collected from the reach of river from the Missouri/Yellowstone River confluence downstream to the headwaters of Lake Sakakawea (Dieterman et al. 1997; Young et al. 1998, Tim Welker, in litt. 1999). Most of the specimens were collected with the benthic trawl. Sturgeon chub and sicklefin chub each comprised 1-2 percent of the total target fish catch in each year.

Additional non-standard benthic trawl and bag seine sampling was conducted by Welker (2000) in the confluence area of the Missouri and Lower Yellowstone Rivers. Welker sampled four river segments in the period July-September 1997 and 1998. The objective of this study was to obtain information on the distribution and habitat use of sicklefin chub, sturgeon chub, and other selected cyprinids. Welker collected 3,033 fish using seines to sample shallow channel border habitat (depths up to 1.5 meters) and a benthic beam trawl to collect fish in deep water habitat of the main channel. Table 7 summarizes collection results for sicklefin and sturgeon chub. Welker's collections were taken during the summer with mean water temperatures from 19.0 to 21.6° (66.2 to 70.9° F) for the four study segments (range 13.9 to 27.6° C - 57.0 to 81.7° F). The majority of sicklefin chub (92 percent) and sturgeon chub were captured in deep water habitat.

The work of Welker, Grisak (1996), and others highlights that the results of seine collections made during the summer in large rivers may not accurately represent the status of sicklefin and sturgeon chub populations.

Table 7. Number and Relative Abundance of Sicklefin and Sturgeon Chub in Samples Collected Near the Confluence of the Yellowstone and Missouri Rivers in 1997 and 1998 (Welker 2000).

	STURGEON CHUB		SICKLEFIN CHUB		TOTAL FISH
	#	% of catch	#	% of catch	#
BORDER CHANNEL					
(Seine)	**24**	**0.01**	**12**	**0.005**	**2,627**
MAIN CHANNEL					
(Benthic Trawl)	**131**	**32.3**	**135**	**33.2**	**406**
TOTAL	**155**	**5.1**	**147**	**4.8**	**3,033**

Fisher (1999) evaluated the importance of backwaters to native fish downstream of the Missouri/Yellowstone Rivers confluence in 1997 and 1998. As part of this study, Fisher found no direct evidence of physical inhabitance of backwater habitats during any life stage of sicklefin or sturgeon chub. He collected 21 young-of-year sturgeon chub and 5 sicklefin chub using a seine to sample shallow water habitat adjacent to sandbars in the main channel of the Missouri River (Fisher, pers. comm. 1999).

During August 1999 and 2000, the Montana Department of Fish, Wildlife, and Parks sampled the Missouri River from Williston, North Dakota, to the headwaters of Lake Sakakawea using a benthic trawl (James Liebelt in litt. 1999 and 2000). Liebelt collected 1,193 fish in 1999, including 132 sturgeon chub (11.1 percent of the catch) and 103 sicklefin chub (8.6 percent of the total catch). Sturgeon chub and sicklefin chub were the second and third most common fish collected, respectively. In August 2000, 44 sturgeon chub and 63 sicklefin chub were collected in the same study area. The sicklefin chub and sturgeon chub ranked third and fourth in abundance, respectively.

Farther downstream in North Dakota, sturgeon chub were found historically in the Little Missouri River, Box Elder Creek, Beaver Creek, Grand River, Green River, Heart River, and White Earth Creek (Reigh 1978, Reigh and Elsen 1979, Reigh and Owen 1979, U.S. Fish and Wildlife Service 1993b). Two sturgeon chub were collected from the Heart River in 1987 (Greg Power, in litt. 1995). The sturgeon chub has not been collected in recent years and is considered extirpated from these streams.

Sturgeon chub were collected at 41 collection sites throughout the length of the Little Missouri River in North Dakota in 1976 and 1977 and at locations in the Lower Yellowstone River (Reigh 1978, Reigh and Elsen 1979). The North Dakota Game and Fish Department collected 55 sturgeon chub, including 2 young-of-the-year, at 4 sample sites in the Little Missouri River during August 1984 (Greg Power, in litt. 1995). However, sturgeon chub were absent from surveys on the Little Missouri in 1990 (Werdon 1992), 1993 (Peterka 1993, Kelsch 1994) and in 1995 (Greg Power, pers. comm. 1997). In August 1997, the Service and the North Dakota Game and Fish Department jointly surveyed 38 sites on the Little Missouri River from the North Dakota/South Dakota border to Lake Sakakawea to establish a baseline inventory of the fish community, but did not collect any sturgeon chub (Wade King, in litt. 1998).

The 85-mile inter-reservoir segment of the Missouri River from the Garrison Dam (river mile 1389) downstream to the headwaters of Lake Oahe (river mile 1304) was sampled in 1996-1998 as part of the Benthic Fish Study. However, no sturgeon chub and no sicklefin chub were captured with the benthic trawl, bag seine, or any other fish collecting gear (Dieterman et al. 1997; Young et al. 1998; Tim Welker, in litt. 1999). Both species are likely extirpated from this reach of river.

South Dakota: Few historical records of the sturgeon chub exist in South Dakota. One collection was made in the 1890s by Evermann and Cox (1896) on the White River. As part of a systematic survey of rivers and streams in the 1950s by Bailey and Allum (1962), sturgeon chub were collected at two locations on the Grand River, at two locations on the Missouri River (one below Fort Randall Dam and one below Gavins Point Dam near Yankton, South Dakota), and at two locations on the White River. In the mid-70s, Bich and Scalet (1977) seined 25 sites on the Little Missouri River in Harding County and found sturgeon chub at 5 locations.

Additional sturgeon chub were not collected in South Dakota until 1993. In 1993 and 1994, the Service and South Dakota Department of Game, Fish, and Parks personnel used seines to document the presence of sturgeon chub at 10 locations on the White River, Little White River, and Cheyenne River (Douglas Hofer, South Dakota Game, Fish, and Parks, in litt. 1995). The species had been collected previously at one of these locations in 1950 by Bailey and Bailey, and in 1951 by Gibbs and Bartel (Bailey and Allum 1962). In 1994, the South Dakota Department of Game, Fish, and Parks conducted a limited seining effort at four sites on the Little Missouri River where Bich and Scalet had collected the species in 1976; however, they did not locate any sturgeon chub (Douglas Hofer, in litt. 1995).

A cursory survey of 35 headwater streams and 4 rivers west of the Missouri River in South Dakota was conducted in 1994 to document the presence and distribution of native fish. Forty-six sites were sampled using bag and wall seines, modified dip nets, and standard metal minnow traps. The survey confirmed the presence of the sturgeon chub in the Cheyenne, White, and Little White Rivers, and extended the range to the Bear-in-the-Lodge Creek, a tributary to the White River (Cunningham et al. 1995).

In 1995, the South Dakota Cooperative Fish and Wildlife Research Unit and the South Dakota Department of Game, Fish, and Parks embarked upon a cooperative effort to intensively survey fish and habitats in the State's major western streams and tributaries. The Upper Moreau River was sampled in 1995 and 1996, and the Belle Fourche and Cheyenne Rivers and tributaries were sampled in 1996 and 1997 by graduate student researchers. Fish populations were sampled using a variety of gear including seines, trap nets, hoop nets, and fyke nets. Chubs and other small fish were primarily collected with seines. No sturgeon chub were collected from either the Belle Fourche River (Doorenbos 1998) or Upper Moreau River (Loomis 1997). A total of 26 sturgeon chub were collected with seines at 5 of 9 reaches on the Cheyenne River between Angostura Reservoir and Lake Oahe (Hampton 1998). The sturgeon chub specimens represented less than 1 percent of the total fish collected (3,896). Although more sturgeon chub were collected in 1997 (15) than in 1996 (11), the species is considered rare (Charles Berry, South Dakota Cooperative Fish and Wildlife Research Units, pers. comm. 1997).

In 1997, the South Dakota Department of Game, Fish, and Parks funded additional surveys on the Cheyenne, Little Missouri, Little White, and White Rivers, and confirmed the presence of the sturgeon chub in all but the Little Missouri River (Cunningham and Hickey 1997). A total of 115 sturgeon chub were found at 10 of 12 sites on the White River. Sturgeon chub also were found at one location each on the Cheyenne River and Little White River. Although the Little Missouri River was intensively surveyed from the Wyoming border to the North Dakota border, sturgeon chub were not collected and appear to be extirpated. Cunningham and Hickey (1997) indicated the reason for extirpation is unclear, but speculate a possible relationship to drought, oil and gas development, and changes in turbidity which warrant research.

In 1998, the fishery resource of the White River again was surveyed. Ninety sturgeon chub were collected from 9 of 11 sample reaches and comprised about 3.6 percent of the total collection of 2,524 fish (Dave Fryda, South Dakota Cooperative Fish and Wildlife Research Unit, in litt. 1999). Cunningham (in litt. 1999) also seined the White River at the Badlands Bombing Range in 1998 and 1999. Approximately 50 sturgeon chub were collected from 2 sites on July 22, 1998, and about 25 specimens were netted from 3 locations on May 16, 1999. Based on this work and previous sampling efforts, Cunningham concluded that sturgeon chub are abundant in the White River.

The sicklefin chub was documented in South Dakota in 1952 (Bailey and Allum 1962) in the Missouri River at five widely separated locations (from the mouth of the Grand River in Corson County to a location below Yankton). The South Dakota Department of Game, Fish, and Parks

believes that historical populations of the sicklefin chub in South Dakota were restricted primarily to reaches of the turbid Missouri River and now considers the sicklefin chub to be extirpated from the State because the main stem reservoirs and remaining riverine reaches no longer provide habitat for this species (Douglas Hofer, in litt. 1995).

The Missouri River from Fort Randall Dam (river mile 880) downstream to the mouth of the Niobrara River (river mile 845) and from Gavins Point Dam (river mile 811) to Ponca, Nebraska (river mile 753), was sampled by Benthic Fish Study researchers in 1996-1998. During the 3-year study, only one sicklefin chub (1996) and no sturgeon chub were collected in about 900 hours of effort with various gears (Dieterman et al. 1997; Young et al. 1998; Brad Young, South Dakota Cooperative Fish and Wildlife Research Unit, in litt. 1999). The one sicklefin chub was collected in a benthic trawl sample taken approximately 6 miles southeast of Burbank, South Dakota, on the western edge of Union County.

MIDDLE MISSOURI RIVER BASIN

The Middle Missouri River basin includes the main stem Missouri River from Gavins Point Dam (river mile 811) in southeastern South Dakota downstream through Iowa and Nebraska to Rulo, Nebraska (river mile 498), near the Nebraska/Kansas State line, and its tributaries, primarily the prairie streams west of the Missouri River.

Nebraska - Iowa: Historical records indicate that sturgeon chub and sicklefin chub were present in the Missouri River in Iowa and Nebraska. Historical abundance data for these species do not exist, although sturgeon chub were reported as abundant in the Missouri River at Sioux City, Iowa, in the late 19th century (U.S. Fish and Wildlife Service 1993b). Most catch records from the 1940s to the present document the capture of a single specimen. During the past 60 years sturgeon chub have been collected in the Missouri River from waters bordering Cass, Dixon, and Thurston Counties, Nebraska, and Mills County, Iowa (Larry Hutchinson, Nebraska Game and Parks Commission, in litt. 1999; Harlan and Speaker 1969). During the same time period, sicklefin chub have been documented in waters bordering Cass, Dakota, Dixon, Knox, Otoe, Richardson, Thurston, and Washington Counties, Nebraska, and Fremont, Harrison, Mills, Pottawattamie, and Woodbury Counties, Iowa (Hesse 1993a; Larry Hutchinson in litt. 1999). Records from the University of Michigan Museum of Zoology indicate that both species occurred in the Missouri River from the Niobrara River to Platte River in Nebraska, in the early 1940s and early 1950s (Douglas Nelson, University of Michigan Museum of Zoology, in litt. 1992).

Since the early 1950s, both the sturgeon chub and sicklefin chub have been rarely collected in the Middle Missouri River. Seining and electrofishing of unchannelized and channelized segments of the river in South Dakota, Nebraska, and Iowa in 1976 failed to capture any sturgeon chub and sicklefin chub (Kallemeyn and Novotny 1977). Hesse (1993a, 1993b, 1994) summarized a number of surveys and reported the results of extensive seining in the Nebraska reach of the

Missouri River from 1970 to 1993. He collected 45,500 small fish using seines during the 24-year study period. The only sicklefin and sturgeon chub collected were single specimens of each species that were captured in the far southeast corner of Nebraska in 1988.

Hesse (in litt. 2000) has continued annual sampling along the nearly 400 miles of the Missouri River that forms the eastern boundary of Nebraska. During the period from 1994 to 1999, 32,650 fish were netted using seines and winged trapnets. Sicklefin and sturgeon chub were the rarest species captured, with a total of two sturgeon chub netted in 1994 and one sicklefin chub collected in 1998 using seines.

Stasiak (1990) reported two sturgeon chub impinged at the Fort Calhoun Power Plant (river mile 646) in 1977 and 1978. The Service (U.S. Fish and Wildlife Service 1993a), citing others, reported the power plant impingement of a total of eight sicklefin chub in 1975, 1980, 1981, and 1982. Except for the 1975 record from river mile 646, all of these sicklefin chub were from the river downstream of the Platte River confluence (river mile 595). From the late 1970s to 1996, no sturgeon chub were collected in the Missouri River above the Platte River confluence. The standardized surveys of the Benthic Fish Study in 1996-1998 found few sturgeon chub (three in 1996 and two in 1997) and no sicklefin chub in the Missouri River segment between the Big Sioux River (river mile 740) at Sioux City and the Platte River confluence (Dieterman et al. 1997; Young et al. 1998; Mark Pegg, Iowa Cooperative Fish and Wildlife Research Unit, in litt. 1999).

Neither species have been collected during sporadic seining of the river near Sioux City, Iowa, over the past 20 years (Rod Tondreau, Western Iowa Technical University, pers. comm. 1995). In the early 1980s, Iowa State University conducted a Statewide fish survey and a Missouri River fish survey for the Corps. Both of these surveys sampled potential sturgeon and sicklefin chub habitat, but no fish were captured (Bruce Menzel, Iowa State University, pers. comm. 1995). Werdon (1992) sampled three Missouri River historical sturgeon chub collection sites in Woodbury County, Iowa, and Thurston and Dixon Counties, Nebraska, during 1989 and 1990. She did not collect either sicklefin or sturgeon chub at these locations.

Stasiak (1990) summarized the literature and historical records pertaining to sturgeon and sicklefin chub in the Nebraska reach of the Missouri River and conducted systematic collections from Sioux City, Iowa, to Rulo, Nebraska, in 1989. A total of 3,800 fish, representing 30 species, were collected using seines. No sicklefin or sturgeon chub were collected during this study. Stasiak concluded sicklefin and sturgeon chub populations are very rare in the Missouri River in Nebraska. In the reach of river between the Platte River confluence and the Nishnabotna River confluence (river mile 595-542), Stasiak (1990) reported two sturgeon chub impinged at a power plant in 1974 and 1982 near river mile 556. More recently, two sturgeon chub were collected at Brownville in 1994 following the 1993 Missouri River flood (Larry Hesse, Nebraska Game, Fish and Parks, pers. comm. 1995). Six sturgeon chub and one sicklefin

chub were collected by Benthic Fish Study researchers during 1996 (Dieterman et al. 1997). Neither species were found in 1997 (Young et al. 1998), but one additional sturgeon chub was collected in this reach of the Missouri River in 1998 (Mark Pegg, in litt. 1999).

During 1999, the Nebraska Game and Parks Commission (1999) monitored fish populations in channelized and unchannelized sections of the Missouri River bordering Nebraska using a variety of gear including hoop nets, electrofishing equipment, gill nets, seines, trammel nets, and a semi-balloon otter trawl. Three sturgeon chub were collected at the Hamburg Bend mitigation site during the spring of 1999. An additional five sturgeon chub were collected in the fall in the dike field at the Tobacco Island mitigation site. The Nebraska Game and Parks Commission reports that the five sturgeon chub collected at Tobacco Island represent 23 percent of all sturgeon chub taken from the Nebraska section of the Missouri River since 1941. The sturgeon chub collected adjacent to Tobacco Island were collected with the otter trawl in mean water depths ranging from 3.1 to 5.8 m (10.2 to 19.0 ft). One sicklefin chub was taken in a benthic trawl sample at the Goose Island control site. Current records suggest that both the sturgeon chub and sicklefin chub exist in very low numbers in the channelized Iowa/Nebraska reach of the Missouri River below the Platte River confluence.

Occurrence records of the sturgeon chubs collected in Nebraska's tributaries to the Missouri River prior to the 1950s are found in Evermann and Cox (1896), Bailey and Allum (1962), and Reno (1969). They reported that the sturgeon chub occurred at scattered locations in the lower Niobrara River, the Republican River, Loup River, Elkhorn River, Platte River, and Bazile Creek. Between 1984 and 1988, the Nebraska Department of Environmental Quality collected more than 70,000 small fish from 350 stream sites across Nebraska; however, no sturgeon chub were collected (Bazata 1991).

In 1989-1990, Werdon (1992) resurveyed historic sites documented by Bailey and Allum (1962) and Evermann and Cox (1896) on the Platte River, but did not relocate sturgeon chub. Werdon (1992) also failed to relocate sturgeon chub at three sites previously documented on the Republican River by Bailey and Allum (1962); one site documented on the Loup River; a site on the eastern Elkhorn River; and a site noted by Evermann and Cox (1896) on Bazile Creek in Knox County.

Sturgeon chub were collected from the Platte River in Dodge County in 1987 (Peters et al. 1989) and Sarpy County in 1991 (Thomas Labedz, University of Nebraska State Museum, in litt. 1992) in low numbers. During extensive sampling of the lower Platte River in 1987, two sturgeon chub were collected near Fremont in Dodge County; five more specimens were collected further downstream in Sarpy County in 1991 (Rowe 1992, Larry Hutchinson, in litt. 1999). On September 19, 2000, the Missouri Department of Conservation and the University of Nebraska collected three sturgeon chub in the Platte River using a benthic trawl, approximately 12 miles upstream of the confluence with the Missouri River (Hrabik in litt. 2000). These were the first specimens collected in the Platte River since 1991. Hrabik suggests that sturgeon chub in the Platte River are uncommon, but may not be as rare as previously suspected.

Outside of the main stem Missouri River, no recent records of sicklefin chub in Nebraska exist. Earlier, Morris (1960) reported collecting sicklefin chub from the Platte River near North Bend and Schuyler, Nebraska, in 1959. However, Stasiak (1990) reported that these specimens were probably misidentified sturgeon chub.

LOWER MISSOURI RIVER BASIN

The Lower Missouri River basin includes the main stem Missouri River and associated tributaries in Kansas and Missouri, downstream of Rulo, Nebraska (river mile 498), to the mouth of the river (river mile 0) north of St. Louis.

Kansas: Historically, the sturgeon chub was a component of the fish fauna of the Missouri and Lower Kansas Rivers in Kansas. The sicklefin chub was present in the Missouri River and rarely captured from the Lower Kansas River (Cross 1967). The last known sturgeon chub and sicklefin chub captured from the Lower Kansas River occurred in 1979 and 1994, respectively (U.S. Fish and Wildlife Service 1993b; Kate Shaw, University of Kansas History Museum, pers. comm. 1995). Prior to the 1994 collection of the sicklefin chub, the next most recent collection record was from 1952 (Cross et al. 1982). Both the 1952 and 1994 collection were presumably the result of migration during flood flows on the Kansas River in 1951 and 1993, respectively. In the Lower Missouri River basin, it is likely that sicklefin chub populations presently occur only in the main stem Missouri River.

In Kansas, numerous field collections were completed in 1992 on the Missouri River between White Cloud, Kansas, and Leavenworth, Kansas, and on the Kansas River from Lawrence, Kansas, to the confluence with the Missouri River. A total of eight sturgeon chub were captured from seven localities on the Missouri River, and no sturgeon chub were captured from the Kansas River. No sicklefin chub were captured from either river (Thomas Wenke, Fort Hays State University, pers. comm. 1993 and 1995). A survey of the Kansas, Republican, and Smoky Hill Rivers in 1991-1992, on or near Fort Riley, Kansas, did not find sturgeon chub. The last collection of the species from this locale was 1964 (Wenke et al. 1993). Werdon also unsuccessfully sampled this locale for sturgeon chub in 1991 (U.S. Fish and Wildlife Service 1993b). In August 1994, three reaches on the Lower Kansas River were sampled for small fishes. No sturgeon chub or sicklefin chub were captured (Vernon Tabor, U.S. Fish and Wildlife Service, in litt. 1994). The reach of the lower Kansas River where sturgeon chub were last captured in 1979, was sampled again in 1997 and 1999. No sturgeon chubs were collected.

A collection locale for both species on the Kansas River at Lawrence, Kansas, has been sampled several times annually since 1951 by staff from the Division of Fishes, University of Kansas Museum of Natural History. Historical fish collections from this locale date to the late 1800s. The last capture of sturgeon chub and sicklefin chub from this area was 1972 and 1994, respectively (Frank Cross, University of Kansas, retired, pers. comm. 1995; Kate Shaw, University of Kansas Natural History Museum, pers. comm. 1995).

Missouri: In 1945, Fisher (1963) established 11 collection sites in the Lower Missouri River from the Iowa-Missouri State line to the confluence of the Missouri River with the Mississippi River. Pflieger and Grace (1987) described Fisher's work as the first thorough survey of fish in the Lower Missouri River. The purpose of this study was to document the fish community before further impoundment of the Missouri River. Only Fort Peck Dam in Montana was in place when Fisher's study was conducted. Fisher primarily used seines to collect small fish from April through October 1945. He collected 24,600 fish, including 66 sicklefin chub and 23 sturgeon chub.

No systematic surveys were conducted during the 1970s, but sturgeon chub and sicklefin chub were collected from northwest and central Missouri by various collectors (U.S. Fish and Wildlife Service 1993a, 1993b). Grace (1985) used seines to sample shallow water areas surrounding two sand islands in the Lower Missouri River. The islands, located at river mile 177.4 and 169.8, were sampled at approximately monthly intervals from July 1982 to October 1983. Sicklefin and sturgeon chub each comprised 1.5 percent of the total catch. Grace noted that catch varied widely by season. Catch rates for sicklefin chub were high during early September 1982 and February through June 1983. During this time, they comprised between 6.9 and 12.7 percent of the catch. During the period from July to October 1983, no sicklefin chub were collected. The catch rates for sturgeon chub were highest from December to June, representing between 8.1 to 24.2 percent of the catch. Few sturgeon chub were collected during the summer.

Data collected in 1982-83 (Grace and Pflieger 1985) indicate that the species' distribution in this reach of the Missouri River remained similar to the 1946-1969 period for sturgeon chub and the 1905-1969 period for the sicklefin chub. Grace and Pflieger (1985) collected 376 sturgeon chub from 7 of 13 sampling sites, although most populations were concentrated in the lower river below central Missouri. The sampling sites were located along the length of the Missouri River in the State of Missouri. Sturgeon chub were collected at three of the eight pre-1969 collection sites. They also reported 590 sicklefin chub from 9 of 13 sampling sites, which corroborated earlier collection locations and river reaches. Sampling effort was not reported.

Pflieger and Grace (1987) used the results presented by Fisher (1963), data they collected (Grace and Pflieger 1985) and studies conducted by other biologists to evaluate how the relative abundance and distribution of fish has changed in the Lower Missouri River from 1940 to 1983. They reported the percent composition of large ($\geq$150 mm total length - 5.9 in) and small (<150 mm total length) fish for the time periods 1940-45, 1962-72, 1978-83. Pflieger and Grace (1987) concluded that both sicklefin and sturgeon chub increased in abundance in the Missouri River below Kansas City. They speculated the Lower Missouri River may be the last stronghold of the sturgeon chub and sicklefin chub.

Gelwicks et al. (1996) revisited historic collection sites that had been sampled by Fisher, Pflieger, and Grace to determine the distribution and relative abundance of sicklefin and sturgeon chub. Thirteen historic collection sites from the Iowa-Missouri border to the mouth of the Missouri River were seined from October 31 to November 15, 1994. Gelwicks collected

6,560 fish, including 3,586 small fish, representing 17 species. The collection contained 163 sicklefin chub and 114 sturgeon chub. Sicklefin chub were captured at all 13 collection sites and sturgeon chub were found at 11 of 13 sites. Gelwicks also collected 18 speckled chub and sturgeon chub hybrids. Table 8 summarizes the results of the studies that have evaluated the relative abundance of small fish in the Lower Missouri River. The table is based on data presented by Pflieger and Grace (1987) and Gelwicks (et al. 1996).

Table 8. Percent Composition of Sicklefin Chub and Sturgeon Chub in the Small Fish Population of the Lower Missouri River 1940-1994.

	1940 - 1945	1962 - 1972	1978 - 1983	1994
SICKLEFIN CHUB	**0.7**	**2.1**	**2.8**	**4.5**
STURGEON CHUB	**0.1**	**0.2**	**0.8**	**3.2**

Gelwicks' sampling indicated an increase in the distribution and abundance of sicklefin and sturgeon chub. It should be noted that while Gelwicks used seines to be consistent with previous studies, his collections occurred in November with water temperatures ranging from 11 to 13° C (51.8 to 55.4° F). Work conducted by Grace (1985), the Missouri Department of Conservation, and others suggest that sicklefin and sturgeon chub may be more commonly found in shallow water areas when the water temperature is less than 15° C (59° F) and thus more readily collected with seines.

In July and August 1997, Grady and Milligan (1998) also sampled historic collection sites on the Lower Missouri River. Nine of 13 historic sites and 2 new sites were seined and trawled. High water conditions, which persisted throughout the 1997 field season, prevented sampling at four of the historic collections sites. Sixty sicklefin chub and 29 sturgeon chub were collected. All sturgeon chub captured during this study and 59 of 60 sicklefin chub were collected in benthic trawl tows.

Grady and Milligan (1998) compared their data to long-term Missouri River data sets from 1944 to 1997, including those reported in Pflieger (1975), Grace and Pflieger (1985), Pflieger and Grace (1987), and Gelwicks et al. (1996). The primary purpose of this study was to evaluate if populations of sicklefin chub, sturgeon chub, and other selected species of cyprinids were declining. Grady and Milligan analyzed the existing data sets to determine the probability of collecting chubs (i.e., presence or absence) over time. They found that the probability of collecting sicklefin chubs in the Lower Missouri River increased from 1945 to 1997. During the same time period, the probability of capturing sturgeon chub remained stable. Grady and Milligan cautioned that although the sturgeon chub population in the Lower Missouri River appears stable, it has declined dramatically throughout most of its range due primarily to changes in the river's channel, turbidity, and hydrograph.

Grady and Milligan (1998) used the most complete long-term data set characterizing sicklefin and sturgeon chub populations throughout their range. Efforts to statistically evaluate the abundance of chubs over time were hampered by the lack of sampling effort data from previous collections. Their study highlights the limitations associated with comparison of historical and current data sets collected during different years, river conditions, and with different sampling protocol. Furthermore, most of the studies have not accounted for differences in gear selection, especially between benthic trawls and seines. Under certain conditions, benthic trawls have become a reliable gear to collect both chub species.

Frank Cross (pers. comm. 1995) suggests that a stable or slightly increasing population of the sturgeon chub in the Lower Missouri River since the 1960s may be related to changes in substrate as sediments are trapped in main stem and tributary reservoirs, and concurrently, the amount of fine gravel, rather than sand, increases in the lower river. In addition to substrate changes, the abundance of sicklefin chub, and to a lesser degree, sturgeon chub, progressively increases downstream, paralleling an increase in the abundance of sandbars, shallow-water habitat, warmer water temperatures, higher turbidity, a more natural hydrograph due to tributary influence and thus, an increase in the frequency of higher river stages and floods during the species' spawning period.

The Service's Columbia Missouri Fishery Resource Office conducted monitoring surveys in a 7-mile reach of the lower Missouri River (river mile 213-219) from 1997 to 1999. A total of 480 sicklefin chub were collected using a benthic trawl (440) and Wisconsin-type mini-fyke nets (40). Seines also were extensively used throughout the 7-mile monitoring area; however, neither species were collected. Over 97 percent of the sicklefin chubs captured were from Jameson Island (river mile 219), a sandbar/wing dike complex and Lisbon Chute (river mile 217), a naturally formed 2-mile side channel containing point/mid-channel sandbars. During the same study, 13 sturgeon chub were captured in benthic trawl tows (Louise Mauldin, U.S. Fish and Wildlife Service in litt. 2000).

The floods of 1993 and 1995 significantly changed the physical character of portions of the Lower Missouri River floodplain when levees failed, and scour holes developed, resulting in the connection of the river and floodplain, which is important to the survival of many native Missouri River species. Analysis of scour holes by the University of Missouri in 1994-1997 documented the use of these habitats by both sicklefin and sturgeon chub and their high value as nursery habitat for larval, juvenile, and young-of-year fish (John Kubisiak, Missouri Cooperative Fish and Wildlife Research Unit, in litt. 1997; John Tibbs, Missouri Cooperative Fish and Wildlife Research Unit, in litt. 1997; Doug Dieterman, Missouri Cooperative Fish and Wildlife Research Unit, in litt. 1999).

A total of 23 sicklefin chub and one sturgeon chub were collected by Kubisiak during 1,214 seine hauls in the Lower Missouri River (river mile 262-160) from April through September in 1995 and 1996. All fish were collected in scour holes either continuously or seasonally connected to the river. Tibbs provided evidence of reproduction in the Lower Missouri River in 1996. He

collected 9 juvenile sicklefin chubs and 133 sicklefin and/or sturgeon chub larvae from 9 scour holes connected to the Missouri River between river mile 300 and 160 from July through September 1996. Gelwicks also documented sicklefin/sturgeon chub larvae at a scour hole near river mile 261 in 1996 and 1997 (Doug Dieterman, in litt. 1999).

In 1996, 1997, and 1998, researchers with the Benthic Fish Study collected 7, 15, and 9 sturgeon chub and 11, 7, and 1 sicklefin chub, respectively, in various river segments between Rulo, Nebraska (river mile 498), and the Grand River (river mile 250) (Dieterman et al. 1997; Young et al. 1998; Pat Braaten, Kansas Cooperative Fish and Wildlife Research Unit, in litt. 1999). During the same study period, they collected 2, 9, and 4 sturgeon chub and 9, 37, and 46 sicklefin chub, respectively, from several locations between Glascow, Missouri (river mile 220), and the mouth of the Missouri (river mile 0) (Dieterman et al. 1997; Young et al. 1998; Doug Dieterman, in litt. 1999). In general, more sturgeon chub and sicklefin chub were collected in 1997 and 1998 than in 1996. Most of the chubs collected were taken by a benthic trawl, and the higher numbers in 1997 and 1998 may reflect the increased sampling effort in those years. The Benthic Fish Study confirmed that sturgeon chub and sicklefin chub increase in abundance progressively downstream and are most common in the lower 130 mi of the Missouri River below the Osage River confluence (river mile 130.4). Although analyses are preliminary, age-growth relationship data (1997-1999) for the sicklefin chub from the Benthic Fish Study suggest that successful recruitment is occurring in those portions of the Missouri River system where the sicklefin chub is still found (Pat Braaten, in litt. 1999).

Etnier (David Etnier, University of Tennessee, in litt. 1996) documented reproduction in the Lower Missouri River below river mile 93 during September and October 1996. He collected 210 sicklefin chub and 81 sturgeon chub from 8 lower river sites. Most of these fish were young-of-year or juveniles. Their capture followed the high 1996 spring flows on the Lower Missouri River. Etnier considered both species as the most abundant cyprinids in his seine hauls. On April 7, 2000, the Missouri Department of Conservation Open River Field Station collected fish samples at Pelican Island. This site is located in the lower Missouri River, approximately 15 miles upstream of the confluence with the Mississippi River. They collected 451 sturgeon chub and 30 sicklefin chub in four benthic trawl tows. The highest number of chubs were collected over clean gravel substrate, approximately 65 m (213 ft) off shore in water depths averaging 1.1 m (3.6 ft). Yearling sturgeon chub and sicklefin chub also were collected near shore with seines in water less than 0.75 m (2.5 ft) deep (Hrabik, Missouri Department of Conservation, in litt. 2000).

MIDDLE MISSISSIPPI RIVER

Collection records for the Middle Mississippi River (Missouri River confluence to the Ohio River confluence) provide an incomplete picture of sicklefin and sturgeon chub populations and how they have changed with time. In general, few records exist, which may reflect little sampling effort or low populations. Researchers familiar with the distribution and relative abundance of fish in the Middle Mississippi River have until recently considered both species to be rare (Pitlo et al. 1995). Recent sampling efforts using an experimental benthic trawl suggest that sicklefin and sturgeon chub may be more common than previously believed.

Missouri - Illinois: Several records exist from the University of Michigan Museum of Zoology (Douglas Nelson, in litt. 1992) for both the sturgeon chub and sicklefin chub, and from Bailey and Allum (1962) for the sturgeon chub in the Middle Mississippi River in Illinois and Missouri from the late 1930s and early 1940s. As is the case with most historical survey data for these chub species, relative abundance data does not exist for the Mississippi River. These records indicate that sturgeon chub were collected from near Chester, Illinois, river mile 110, downstream to the river's confluence with the Ohio River. Smith (1979) reported records from Madison and Union Counties, Illinois, but dates of collection are unknown. Madison County is in the uppermost reach of the Middle Mississippi River near St. Louis and the Missouri River confluence. Records from the University of Kansas Natural History Museum list the sicklefin chub in the Mississippi River in St. Charles, Perry, Scott, and Mississippi Counties, Missouri, in the early 1960s (Kate Shaw, pers. comm. 1995).

Klutho (1983) collected 5,480 fish seining shoreline habitat (depths up to 1.5 m - 4.9 ft) at 2 locations near Grand Tower, Illinois, from April 1978 to February 1983. He classified the sturgeon chub as rare and the sicklefin chub as common at Grand Tower, Illinois. During this study, 61 species were collected, including 5 juvenile sturgeon chub and 65 sicklefin chub. The sicklefin chub ranked 13th in abundance and represented slightly over 1 percent of the total catch. Statistical analysis revealed that the presence of sicklefin chub was correlated with high water levels, sand substrate, and water temperatures ranging from 2 to 9° C (35.6 to 48.2° F). Klutho found sicklefin chub were most prevalent in shallow water during the late winter and early spring. He hypothesized that sicklefin chub may move inshore to avoid being washed downstream during period of high flows.

Grace and Pflieger (1985) surveyed 16 sites on the Mississippi River bordering Missouri, including 10 locations along the Middle Mississippi River. They collected 54,900 fish, representing 84 species using seines and electrofishing equipment. Small fish collections, using seines to sample shallow water habitat, were conducted between June 27 and September 15, 1983. No sicklefin or sturgeon chub were collected in samples taken from the Mississippi River.

In Illinois, both chub species are considered to be rare; however, the sicklefin chub is reported to be more common than the sturgeon chub (Smith 1979). Since 1986, the Illinois Department of Conservation has seined 33 sites between Lock and Dam 22 and Thebes, Illinois, 3 times each

summer to monitor reproduction and recruitment of riverine fishes. No sturgeon chub or sicklefin chub have been collected since monitoring began (Butch Atwood, Illinois Department of Conservation, pers. comm. 1995). Sicklefin chub are occasionally found at Grand Tower during annual qualitative sampling; the fish are suspected to be young-of-year and no adults are collected (Brooks Burr, pers. comm. 1995).

In 1996, Southern Illinois University conducted a study for the Illinois Department of Natural Resources to determine the present distribution and abundance of the sturgeon chub and sicklefin chub in Illinois, and among other objectives, to document historical changes in distribution and abundance (Piller et al. 1996). Seines were used to provide a basis for comparison of historical and current data. Eleven sites (both historical and new localities with potential suitable habitat) were sampled from September 1995 to July 1996; however, neither species was collected. Both species were previously present in collections from the early 1980s and mid-1990s following floods, but absent during many intervening years. They concluded, based on gear compatibility, that both species had declined in distribution and abundance in the Middle Mississippi River.

Etnier (David Etnier, in litt. 1996) collected two sturgeon chub and one sicklefin chub in the Middle Mississippi River at three sites from Scott County, Missouri, to the mouth of the Missouri River during the fall of 1996.

The Missouri Department of Conservation Open River Field Station has used a variety of gear since 1991 to sample fish populations in the Middle Mississippi River (Hrabik, in litt. 2000a). In 1997, they added small mesh netting and made other modifications to a standard slingshot-balloon trawl. The modified or experimental benthic trawl has allowed researchers to more effectively sample small fish, including sicklefin and sturgeon chub. The experimental benthic trawl has permitted fishery biologists to collect small fish in deep water habitat where seining or other collection methods can not be used or are ineffective.

During the 9-year period from 1991 to 1999, the Open River Field Station did not collect sturgeon chub in the Middle Mississippi River using a variety of gear, including seines, minnow fyke nets, and standard trawling equipment. However, during the past 4 field seasons (1997-2000), 227 sturgeon chub were collected using the modified or experimental benthic trawl. The number of sicklefin chub collected also has substantially increased. From 1991 to 1999, 55 sicklefin chub were captured using various gear. Since 1997, 209 sicklefin chub have been collected with the experimental benthic trawl in the Middle Mississippi River (Hrabik and Herzog, Missouri Department of Conservation, in litt. 2000a,b).

Hrabik (in litt. 1993 and 1997) had previously indicated that no conclusive evidence existed to suggest that sicklefin chub and sturgeon chub in the Middle Mississippi River were members of a viable, self-sustaining population. Prior to employing the experimental benthic trawl in 1997, Open River Field Station biologists considered both species to be waifs or transient fish from the Lower Missouri River. Trawling data collected during the past four field seasons confirm the presence of a viable population of both sicklefin and sturgeon chub in the Middle Mississippi

river. Based on the short-term data set collected during the past 4 years, Hrabik and Herzog (in litt. 2000a, b) indicated that sturgeon chub are uncommon, but not rare, and their numbers are steady to slightly increasing. Sicklefin chub are uncommon and perhaps borderline rare in the Middle Mississippi River. Collections made during the past four field seasons suggest that sicklefin chub numbers are slightly decreasing. However, additional data is needed to establish reliable population trends for sicklefin and sturgeon chub.

LOWER MISSISSIPPI RIVER

Missouri - Kentucky - Tennessee - Arkansas - Mississippi - Louisiana: Few historical records exist for sturgeon chub and sicklefin chub from the Lower Mississippi River from the mouth of the Ohio River to the Gulf of Mexico. Records are more sparse on the Lower Mississippi River system than the Middle Mississippi River and have been reported only from the main stem Mississippi River and not from tributaries. The lack of records for sicklefin chub and sturgeon chub from the Lower Mississippi River may be due, in part, to a reduced sampling effort and limited trawling by comparison to the effort expended on the Missouri and Middle Mississippi Rivers.

The most current fishery study documenting the presence of sicklefin and sturgeon chub is ongoing work being conducted by the Missouri Department of Conservation Open River Field Station. During 2000, the Wolf Island Chute, a 4.3-mile area located approximately 24 miles downstream from the mouth of the Ohio River was sampled on three occasions. Complete data summarizing these collections are not currently available; however, based on initial field assessments, Hrabik and Herzog (in litt. 2000a) believe a viable population of both sicklefin and sturgeon chub exist in the Wolf Island area. Both species are less abundant in the Lower Mississippi River than the Middle Mississippi River, despite what appears to be an abundance of adequate habitat.

Other occurrence records for sicklefin and sturgeon chub in the Lower Mississippi River document small collections (one to three fish) over the last 60 years. Three pre-1980 records exist for the sicklefin chub from the Lower Mississippi River. Etnier and Starnes (1993) reported a 1940 record from the Missouri shore of the Mississippi River at Cottonwood Point, Pemiscot County, across the river from Dyer County, Tennessee. Burr and Warren, Jr. (1986) reported a 1944 University of Michigan Museum of Zoology record from the Mississippi River at the Ohio River confluence, Alexander County, Illinois, for both the sturgeon chub and sicklefin chub. Records from the University of Kansas Natural History Museum (Kate Shaw, pers. comm. 1995) document the occurrence of the sicklefin chub from the Lower Mississippi River (Mississippi County, Missouri) in the early 1960s.

Etnier and Starnes (1993) reported two records of sturgeon chub from near the Hatchie River confluence in Tipton County, Tennessee. These records are apparently the same records mentioned by Robison and Buchanan (1988) and the same as a 1981 record cited in U.S. Fish

and Wildlife Service (1993b). Robison and Buchanan (1988) also reported one collection (one specimen) from Mississippi County, Arkansas, which is on the opposite shore from Tipton County.

In addition to these records, Robison and Buchanan (1988) reported a 1980 Mississippi River sicklefin chub record of two small specimens from near Blytheville, Mississippi County, Arkansas. They also noted collection of the first record (1980, three specimens) of this species in Tennessee, from the Mississippi River in Lauderdale County (across the river from Mississippi County, Arkansas). No more recent collections of the sicklefin chub or sturgeon chub have been reported in Arkansas (Henry Robison, University of Southern Arkansas, pers. comm. 1995; Cindy Osborne, Arkansas Natural Heritage Commission, pers. comm. 1997). In 1994, sicklefin chub were captured near the mouth of the Obion River (Dyer and Lauderdale Counties, Tennessee), about 19 km (12 mi) downstream of Cottonwood Point, by Dr. David Etnier, University of Tennessee at Knoxville (Ron Cicerello, Kentucky State Nature Preserves Commission, pers. comm. 1995). The 1944 record from Missouri, the 1980 records from Blytheville and Lauderdale Counties, and Etnier's 1994 record, all come from the same vicinity.

Extensive sampling of main channel, side channel, and inlet habitats around seven sand islands in the Lower Mississippi River in Missouri and Kentucky by seining during May-July of 1993 and 1994 failed to capture sturgeon chub, but captured one juvenile sicklefin chub (John Tibbs, in litt. 1995). This specimen was collected near river mile 835 in Fulton County, Kentucky.

The sturgeon chub has not been reported from Mississippi and only four collection records of the sicklefin chub exist for the State. In the spring of 1973, two sicklefin chub were collected from the Vicksburg Power Plant intake screen and a single specimen was caught in the Mississippi River from waters bordering Claiborne County, Mississippi (Guillory 1979). During the fall of 1973, two additional sicklefin chub were captured as part of the Grand Gulf Nuclear Power Plant survey. They were collected from the Mississippi River using a 16-foot otter trawl (Todd Slack, Mississippi Museum of Natural History, pers. comm. 2000). Ross (1991) reported a single record of sicklefin chub in Mississippi from near Vicksburg. No more recent collections exist (Steve Ross, pers. comm. 1995 and 1997). Ross categorized the conservation status of the sicklefin chub in Mississippi as rare (usually collected as single individuals) and peripheral (a species whose main distribution is outside of Mississippi and is only represented in the State by occasional waifs). In Louisiana, the sturgeon chub is rare and represented by one specimen, which was collected in the Mississippi River in West Feliciana Parish (Henry Bart, Tulane University, pers. comm. 1995). No records of the sicklefin chub have been reported for Louisiana.

V. SICKLEFIN CHUB STATUS SUMMARY

Since 1993, when the Service completed a Sicklefin Chub Status Report, surveys have been conducted throughout most of this species' historic range. These studies indicate that sicklefin chub are more common and more widely distributed than previously believed. The efficiency of

sampling techniques have dramatically improved with the use of benthic trawls that have been modified to collect small fish. Benthic trawls have permitted sampling in deep water habitats where seines, the traditional cyprinid collection method, are ineffective or cannot be used.

Collection records for sicklefin chub indicate that this species historically occurred in 70 miles of the Lower Yellowstone River, 1,950 miles of the main stem Missouri River, and 1,150 miles of the Mississippi River, below the mouth of the Missouri River. Based on field studies conducted during the past decade, sicklefin chub currently occupy approximately 1,090 miles in the Missouri River drainage or 54 percent of its historic range.

Information documenting the presence of sicklefin chub in the Mississippi River is limited by comparison to the Missouri River data set. Field studies conducted by the Missouri Department of Conservation since 1997 have documented viable populations of sicklefin chub in the Middle Mississippi River and in the Wolf Island area of the Lower Mississippi River. Historic collections of sicklefin chub in the Lower Mississippi River below Wolf Island are rare and generally document the presence of an individual fish. Sufficient data does not exist to determine if the Lower Mississippi River provided important habitat for sicklefin chub.

Recent studies using benthic trawls indicate that sicklefin chub are a significant part of the fishery at three locations in the Missouri River drainage--above Fort Peck Reservoir in Montana; the Yellowstone/Missouri River confluence area in North Dakota and Montana; and the lower Missouri River in Missouri. Grisak (1996) used both seines and a benthic trawl to sample the fish population in the Missouri River above Fort Peck Reservoir in 1994 and 1995. He found sicklefin chubs comprised 21.9 percent of the benthic trawl catch and only 0.08 percent of the catch with seines. Sicklefin chubs were the second most common species collected in benthic trawl tows. In 1999 and 2000, Gardner (2000a,b) sampled the same general area as Grisak. The sicklefin chub was the most common species collected in 1999 (41.5 percent of the catch) and the third most common species collected in 2000 (5.1 percent of the catch). Welker (2000) used both seines to sample shallow border channel habitat and a benthic trawl to sample deep water habitat in the Yellowstone/Missouri River confluence area in 1997 and 1998. Sicklefin chub were the most common species collected in benthic trawl tows, comprising 33.2 percent of the trawl catch. By contrast, only 12 sicklefin chub were collected in seine hauls (0.005 percent of the catch using seines). Liebelt (in litt. 1999) sampled the Missouri River above the headwaters of Lake Sakakawea in 1999. Sicklefin chub were the third most common species collected, making up 8.6 percent of the catch. Grady and Milligan (1998) sampled the Missouri River in Missouri in 1997. They collected 3,934 fish in seine hauls, including one sicklefin chub. By contrast, sicklefin chubs were the second most common species collected with a benthic trawl (8.4 percent of the catch).

Construction of six dams and reservoirs on the main stem Missouri River from 1937 to 1964 as part of the Pick Sloan Plan and their continued operation is the major factor that has impacted sicklefin chub populations. Completion of the dams converted 800 miles of turbid, riverine habitat to lentic systems. Sicklefin chubs, which are highly adapted to conditions found in large,

turbid river systems, have been extirpated from the reservoirs and the free-flowing reaches below Garrison, Oahe, Big Bend, and Fort Randall Dams in North and South Dakota. Sicklefin chub likely become easy prey for sight-feeding piscivorous fish in the relatively clear water conditions found in these areas. Sicklefin chub are found in low numbers in the Missouri River from Gavins Point Dam downstream to the Missouri border.

VI. STURGEON CHUB STATUS SUMMARY

Historically, the sturgeon chub occurred throughout 2,100 miles of the main stem Missouri River and 1,150 miles of the main stem Mississippi River. The species also was found in the Yellowstone River in Montana and North Dakota and 30 tributaries to the Yellowstone and Missouri Rivers. The sturgeon chub occurred in portions of four tributaries in Wyoming, nine in Montana, five in North Dakota, six in South Dakota, six in Nebraska, and four in Kansas. Tributaries such as the Powder River, which provides sturgeon chub habitat in both Wyoming and Montana, are included in the tallies for both States. Other tributaries that historically provided sturgeon in two States include the Big Horn, Little Missouri, and Republican Rivers.

Sturgeon chub currently occupy approximately 1,155 miles or about 55 percent of its former range in the Missouri River. The species also continues to be found in 11 of 30 tributaries to the Yellowstone and Missouri Rivers that were documented as providing sturgeon chub habitat. As with the sicklefin chub, information documenting sturgeon chub populations in the Mississippi River is limited by comparison to the Missouri River data set. Field studies conducted by the Missouri Department of Conservation since 1997 have documented a viable population of sturgeon chub in the Middle Mississippi River and in the Wolf Island area of the Lower Mississippi River (Hrabik and Herzog 2000a,b). Historic collections of sturgeon chub below Wolf Island are rare and do not provide adequate information to assess if this area historically provided important sturgeon chub habitat.

The distribution of sturgeon chub in the main stem Missouri and Mississippi Rivers is similar to that of the sicklefin chub. Both species are highly adapted for conditions found in free-flowing rivers with high turbidity levels in the main channel. Like the sicklefin chub, sturgeon chub comprise a significant portion of the Missouri River fish community above Fort Peck Reservoir in Montana, in the Yellowstone/Missouri River confluence area in Montana and North Dakota, and in the Lower Missouri River in Missouri.

Recent studies using benthic trawls designed to collect small fish from deep water areas of the main channel have increased information about the distribution and relative abundance of sturgeon chub. Grisak (1996) conducted the first studies using a benthic trawl with small mesh netting to specifically collect cyprinids and other small fish in the Missouri River. He sampled the Missouri River above Fort Peck Reservoir in 1994 and 1995 and found that sturgeon chub comprised 18.9 percent of the benthic trawl catch and only 0.16 percent of the catch with seines. In Grisak's study, sturgeon chub were the third most common species collected in benthic trawl tows. In 1999 and 2000, Gardner (1999, 2000) sampled the same general area as Grisak.

Gardner collected 218 sturgeon chub (16.1 percent of the catch) in August 1999 and 145 sturgeon chub (32.0 percent of the catch) in August 2000 using a benthic trawl. Welker (2000) used both seines and a benthic trawl to sample the fish population in the Yellowstone/Missouri River confluence area in North Dakota. Sturgeon chub were the second most common species collected (32.3 percent of the catch) in benthic trawl samples taken in the main channel. Shallow border channel areas also were sampled with seines. Sturgeon chubs were rare in seine samples, representing less than 0.01 percent of the catch. Liebelt (in litt. 1999) sampled a reach of the Missouri River from Williston, North Dakota, downstream to the headwaters of Lake Sakakawea in August 1999. Sturgeon chubs were the second most common species collected, representing 11.1 percent of the catch in benthic trawl tows. In Missouri, Grady and Milligan (1998) sampled the Lower Missouri River in 1997. They collected 3,934 fish with seines; however, no sturgeon chub were captured. Sturgeon chub ranked fourth in abundance for fish collected in benthic trawl tows (4.1 percent of the catch).

VII. DISTINCT POPULATION SEGMENTS

The Service and the National Marine Fisheries Service have adopted criteria (61 FR 4722) for listing, delisting, and reclassifying unique stocks under the ESA. To constitute a distinct population segment, a stock or group of stocks must be--(1) discrete (i.e. spatially separate) from other stocks of the taxon), (2) significant (e.g. ecologically unique for the taxon; extirpation would produce a significant gap in the taxon range; the only surviving native stock of the taxon; or there is substantial genetic divergence between the stock and other stocks of the taxon, and (3) the status of the stock must warrant protection under the ESA.

Sicklefin and sturgeon chub populations on the Missouri River basin may be effectively isolated by the Missouri River main stem dams. Sicklefin and sturgeon chub populations meet the criterion for discreetness. As a result, the second criterion, that of significance (e.g., genetically or ecologically unique) must be addressed.

Dieterman (2000) examined sicklefin chub collected throughout their range in the Missouri and Lower Yellowstone Rivers, measuring 18 phenotypic traits and using multi-variance spatial techniques to explore patterns of spatial variation that might suggest phenotypically distinct populations. Determan found that intra-segment variation in sicklefin chub populations phenotypic traits currently exceeds inter-segment variation. This research indicates that phenotypically distinct populations in the Missouri River do not exist, despite river regulation.

Similar studies to evaluate phenotypic traits of sturgeon chub have not been conducted. However, given the short time that the Missouri River main stem dams have been in place, the Service does believe that genetically or ecological populations of sturgeon chub have developed. Testing to evaluate genetic variation within sicklefin and sturgeon chub populations have not been conducted.

The Service found no morphological, physiological, or ecological data during this status review process indicating unique adaptations of individual stocks or assemblages of sicklefin or sturgeon chub within the range of these species. Chub populations could meet the discreetness criterion; however, there is no evidence supporting the second criterion, that genetically or ecologically significant stocks have developed. Therefore, single populations of sicklefin chub and sturgeon chub are recognized for the purposes of this updated status review.

VIII. LAND OWNERSHIP

Within the wide geographic range of the sturgeon chub and sicklefin chub, ownership and management of the rivers, tributaries, and adjacent uplands varies by State and waterway. Ownership of the uplands adjacent to the Missouri River and its tributaries is primarily private, but also includes a mixture of Federal, State, tribal, and municipal lands. Management of reservoir elevations and annual operations on the lower six Missouri River main stem reservoirs and dams is the responsibility of the Corps. Reclamation has similar responsibilities for the Canyon Ferry Reservoir, the uppermost reservoir on the main stem Missouri River in Montana, and many of the tributary dams, reservoirs, and low-head diversion dams. The Corps also has primacy for operation and maintenance of the Missouri River Bank Stabilization and Navigation Project and a number of tributary reservoirs, especially in the Kansas and Osage River basins.

IX. PREVIOUS FEDERAL ACTION

The sicklefin chub and sturgeon chub first received listing consideration when the two species were included in the September 18, 1985, Animal Candidate Review for Listing as Endangered or Threatened Species (50 FR 37958) as category 2 candidate species for listing. Category 2 status comprised taxa for which information indicated that a proposal to list as endangered or threatened is possibly appropriate, but for which conclusive data on biological vulnerability and threats are not currently available to support proposed rules. The Service initiated individual status reviews in 1992 and subsequently published status reports on each species in August 1993 (U.S. Fish and Wildlife Service 1993a, 1993b).

On July 11, 1994, the Service reclassified both the sicklefin chub and sturgeon chub as category 1 candidate species and announced this reclassification in a revised animal notice of review on November 15, 1994 (59 FR 58982). Category 1 status comprised taxa for which the Service had substantial information on biological vulnerability and threats to support proposals to list the taxa as endangered or threatened species. As of February 26, 1996, the Service no longer classifies candidate species by category. The chubs are now simply termed a candidate species, and each has a listing priority of 2.

On August 8, 1994, the Service received a petition from the Environmental Defense Fund, which was jointly signed by American Rivers, Mni Sose Intertribal Water Rights Coalition, National Audubon Society, and the Nebraska Audubon Council, to list both the sicklefin chub and sturgeon chub as endangered. The petitioners asserted that these species should be listed as

endangered species because of their inability to adapt to human-induced alterations of the Missouri River. They indicated that sicklefin chub and sturgeon chub are physically adapted through evolution to live in turbid, swift-flowing rivers. Alterations described by the petitioners include impoundments, channelization, and removal of snags. The petitioners indicated that these alterations have detrimentally impacted the fishes' spawning and feeding habitat by changing the natural hydrograph and water temperatures and halting sediment movement, which reduced turbidity, and reducing the amount of organic matter transported by the Missouri River (Hesse 1994).

Following a review of the petition, its supporting documents and data, and other available information about the status, distribution, abundance, and threats to the sicklefin and sturgeon chub, the Service published a notice in the January 18, 1995, Federal Register of a 90-day petition finding (60 FR 3613). The Service found that substantial information existed to indicate that listing the sicklefin chub and sturgeon chub may be warranted.

Section 4(b)(3)(B) of the ESA, requires that, for any petition to revise the List of Endangered and Threatened Wildlife and Plants that contains substantial scientific and commercial information, the Service make a finding within 12 months of the date of receipt of the petition on whether the petitioned action is--(a) not warranted, (b) warranted, or (c) warranted but precluded from immediate proposal by other pending proposals of higher priority. Completion of the 12-month finding and a potential listing proposal was delayed by a Congressional moratorium in 1995 and 1996 on listing packages, Service backlog of listing actions and low funding priorities for the chubs in 1996 and 1997, and Service and State comments requesting that data from several comprehensive fish surveys (1995-1998) throughout the chubs' historical range be incorporated into the listing package. The Service prepared an initial draft 12-month finding in August 1995 and updated the draft finding in 1997 and 1999.

On April 6, 2000, the Montana Rivers Coalition Inc. filed a 60-day notice of intent to sue because of the Service's failure to complete a 12-month finding on a petition to list the sicklefin chub and the sturgeon chub, as required by Section 4 of the ESA. This action led to a final stipulated settlement agreement being signed and entered by the United States District Court, Missoula, Montana, on October 6, 2000. The settlement agreement stipulated that the Service shall submit for publication in the Federal Register a 12-month determination for the sicklefin chub and the sturgeon chub on or before April 12, 2001.

X. SUMMARY OF FACTORS AND THREATS AFFECTING THE SPECIES

Section 4(a)(1) of the ESA and regulations (50 CFR Part 424) promulgated to implement the listing provisions of the ESA set forth the procedures for adding species to the Federal "List of Endangered and Threatened Wildlife and Plants." A species may be determined to be an endangered or threatened species due to one or more of the five factors described in Section 4(a)(1). Each of the five factors will be addressed for sicklefin chub and then sturgeon chub. The information presented for sicklefin chub populations applies to the sturgeon chub as their

range and habitat use overlap. The range of sturgeon chub extends further than sicklefin chub, including tributaries to the Yellowstone and Missouri Rivers. The discussion of the factors affecting sturgeon chub primarily focuses on additional factors unique to this species.

SICKLEFIN CHUB

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range.

Missouri River Main Stem Dams: Destruction and alteration of big-river ecological functions and habitat once provided by the Missouri and Mississippi Rivers are believed to be the primary cause of declines in the habitat and range of the sicklefin chub. The physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity and nutrient inputs once functioned within the big-river ecosystem to provide habitat for sicklefin and other native species. Today on the main stem Missouri River, approximately 36 percent of riverine habitat within the sicklefin chub's historic range, has been transformed from river to lake by construction of six massive earthen dams by the Corps between 1937 and 1964 (U.S. Fish and Wildlife Service 1993c). Another 40 percent of the river downstream of dams has been channelized. An additional 24 percent of river habitat has been altered by changes in water temperature and flow caused by dam operations.

Missouri River aquatic habitat downstream of the six main stem dams has been and continues to be altered by reductions in sediment and organic matter transport/deposition, flow modification, hypolimnetic releases, and narrowing of the river through channel degradation. Those activities have adversely impacted the natural river dynamics by reducing the diversity of bottom contours and substrate, slowing accumulation of organic matter, reducing overbank flooding, changing seasonal flow patterns, severing flows to backwater areas, and reducing turbidity and water temperature (Hesse 1987). The Missouri River dams also are believed to have adversely affected sicklefin chub by fragmenting habitats and effectively isolating populations. The reaches below the main stem dams also have been affected by a proliferation of bank stabilization projects in the past 10 years. Cumulatively, these projects may adversely affect aquatic habitat by increasing river velocities and river bed degradation; and reducing sediment input into the system, sandbar formation, and shallow water habitat.

The pattern of flow velocity, volume, and timing of the pre-development rivers provided the essential life requirements of native large-river fish like the sicklefin and sturgeon chub, pallid sturgeon, and paddlefish. Hesse and Mestl (1993) found a significant relationship between the density of paddlefish larvae and two indices (timing and volume) of discharge from Fort Randall Dam. They concluded that when dam operations caused discharge to fluctuate widely during spring spawning, the density of drifting larvae was lower, and when annual runoff volume was highest, paddlefish larval density was highest. Hesse and Mestl (1987) also modeled these same two indices of discharge from Fort Randall Dam with an index of year-class strength. They demonstrated significant negative relationships between

artificial flow fluctuations in the spring and poor year-class development for several native and introduced fish species; river carpsucker (*Carpiodes carpio*), shorthead redhorse (*Moxostoma macrolepidotum*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), sauger (*Stizostedion canadense*), smallmouth buffalo (*Ictiobus bubalus*), and bigmouth buffalo (*I. cyprinellus*). The sample size of sturgeon was too small to model in that study; however, a clear relationship existed between poor year-class development in most native species studied and the artificial hydrograph.

Modde and Schmulbach (1973) found that during periods of low dam releases, the secondary subsidiary channels, which normally feed into the river channel, become exposed to the atmosphere and thus cease to contribute littoral benthic organisms into the drift. Schmulbach (1974) states that use of sandbar habitats were second only to cattail marsh habitats as nursery grounds for immature fishes of many species.

Construction and the continuing operation of the main stem dams on the Missouri have significantly altered the Missouri River ecosystem and the habitat historically used by sicklefin and sturgeon chub. The degree of impact to chub populations varies, depending upon location with the system. In locations where the Missouri River is free-flowing and carries relatively high levels of turbidity, sicklefin and sturgeon chub comprise a substantial portion of the population collected in benthic trawl samples. In reaches of the river system that have been converted to reservoir habitat or short, free-flowing inter-reservoir reaches with relatively low turbidity levels, chub populations have been extirpated.

Missouri River Bank Stabilization and Navigation Project: Historically, the main channel of the Missouri River changed course, relocating over 610 m (2,000 ft) in some years. The river transported large amounts of sediment that created braided channels in the meandering river. The braided channel restricted navigation and periodically flooded bottomland farms and communities along the river.

Authorization of the Rivers and Harbors Act between 1912 and 1945 established a program to channelize the Missouri River from Sioux City, Iowa, to the mouth of the Missouri River near St. Louis, Missouri. This program, known as the Missouri River Bank Stabilization and Navigation Project (BSNP), created one stabilized channel from the numerous small channels. The project consists mainly of revetments along the outside bends and transverse dikes along the inside bends to force the river into a single active channel that is self-sustaining. Officially completed in 1981, the existing project extends from Sioux City, Iowa, to the mouth of the Missouri River (735 mi) and maintains a 2.7-m deep (9-ft deep) by 91-m wide (300-ft wide) channel. The Corps conducts annual maintenance surveys and activities to ensure the continued integrity and function of the existing BSNP structures.

Morris et al. (1968) found that channelization of the Missouri River reduced the surface area by approximately 67 percent. Funk and Robinson (1974) calculated that the length of the Missouri River between Rulo, Nebraska, and its mouth (~500 RM) had been reduced by 8 percent, and the water surface area had been reduced by 50 percent following channelization.

Since 1974, the Corps has implemented measures to modify the channel maintenance structures and improve fish and wildlife habitat. The Corps has restored some side-channel connections and increase habitat diversity in the channelized Lower Missouri River by notching dikes or otherwise modifying channel structures (Burke and Robinson 1979). The Corps estimates that approximately 2,600 notches have been constructed. Notching dikes or revetments can increase channel width and diversity, and create substantial shallow-water/sandbar complexes at certain river stages. After the 1993 flood, revetment repairs that allowed continued riverine connection to off-channel scour holes and chutes also have helped maintain habitat diversity and value, particularly for riverine fishes.

Channelization of the Missouri River to create a self-sustaining navigation channel has reduced habitat diversity and adversely affected fish and wildlife habitat. Sicklefin and sturgeon chub populations exist in low numbers from Gavins Point Dam to St. Joseph, Missouri. Research studies conducted in the Missouri River in Missouri from the 1940s to the 1990s indicate that the relative percentage of sicklefin and sturgeon chub in small fish collections has increased. Unfortunately, baseline data characterizing chub populations in the Missouri River prior to the authorization and initial construction of the BSNP do not exist.

In 1986, Congress authorized mitigation for fish and wildlife resources lost due to the construction, operation, and maintenance of the BSNP. Please see ongoing regulatory and conservation action for further discussion of the BSNP mitigation plan.

Mississippi River Channelization: Construction activities to create and maintain a navigation channel in the Middle Mississippi River have been ongoing since 1927. Approximately 111 miles of stone dikes, 169 miles of rock revetment, and 16 miles of bendway weirs have been constructed to narrow the channel for navigation. This work, which alters or removes shallow, sandbar habitat used by chubs, is about 66 percent complete and is scheduled to be finished in 2014. Most side channels and islands were cut off from the main channel by closing structures. Wing dikes have reduced average width from about 1,615 m (5,300 ft) in 1888 to about 975 m (3,200 ft) in 1968, for a total reduction of about 40 percent (Rasmussen 1979). Currently, about 14,569 hectares (ha) (36,000 acres (ac)) of unvegetated sandbar habitat remain (U.S. Army Corps of Engineers 1997). Future plans call for constricting the river top width to 457 m (1,500 ft) between the distal ends of the wing dikes.

Levee construction on the Lower Mississippi River, from the Ohio River to the Gulf of Mexico, has eliminated the river's major natural floodway and reduced the area of the floodplain connected to the river by more than 90 percent (Fremling et al. 1989). Fremling et al. (1989) also report that levee construction isolated many floodplain lakes and raised river banks. As a result of levee construction, 15 meander loops were severed between 1933 and 1942.

We find that sicklefin and sturgeon chub habitat has been reduced by efforts to constrict and control the Missouri and Mississippi Rivers with reservoirs, stabilized banks, jetties, dikes, levees and revetments. However, segments of the Missouri and Mississippi Rivers continue to support self-sustaining population of sicklefin chub, and future construction should not reduce the existing habitat to levels that would eliminate viable populations. Studies conducted in Montana, North Dakota, and Missouri using benthic trawls indicate that sicklefin and sturgeon chub comprise a significant portion of the fish population in segments of the Yellowstone and Missouri Rivers. Recent studies conducted by the Missouri Department of Conservation have documented viable populations of both sicklefin and sturgeon chub in the Middle Mississippi River and in the Wolf Island area of the Lower Mississippi River.

Water Depletions: Water depletion projects for municipal, agricultural, and energy related industrial uses within the Missouri River basin may impact sturgeon chub and sicklefin chub populations and habitats. Areas of concern are water depletion projects in the Upper Missouri River and Lower Yellowstone River basin in Montana and North Dakota, and the Platte River in Nebraska. Much of the flow of the Platte River has been depleted and other water development projects have been proposed or are under construction in the Colorado and Wyoming portions of the basin. The Lower Platte River has experienced substantial depletion of flows during high runoff periods over the past century (Williams 1978, Eschner et al. 1983).

The Lower Yellowstone River and Missouri River upstream and downstream of the confluence of these two rivers, collectively known as the Mon-Dak irrigation frontier, are subject to considerable water depletion projects for irrigation purposes. In 1997, Reclamation (1999) conducted an inventory of major water diversions on the Lower Yellowstone River between Billings, Montana, and the North Dakota State line. Reclamation documented six low-head dam irrigation diversion projects, four irrigation diversions using lateral dikes, seven pumped irrigation diversion projects, and a number of industrial and municipal water diversions in this reach of river. The Mon-Dak region currently supports over 171,000 ac under irrigation.

In March 1998, Montana Governor Marc Racicot established the Vision 2005 Task Force on Agriculture. The Task Force was developed to address the goal of doubling agriculture’s economic value by the year 2005. The Task Force established the goal of increasing irrigation in eastern Montana by 500,000 ac. Expansion of irrigation to meet the task force

goal will require an unquantified amount of water depletions from the Yellowstone and Missouri Rivers and their tributaries. Planning is currently ongoing for the West Crane Sprinkler Irrigation Project southwest of Sidney, Montana. The Richland County Conservation District is seeking authorization to divert 24,000 acre-feet from the Yellowstone River to irrigate 12,000 ac of existing dry land agriculture. As the overall amount, timing and locations of these potential depletions are currently unknown, we cannot evaluate the impact of these proposals on aquatic resources at this time.

Irrigation diversion dams and other types of river diversion structures in the upper basin have the greatest potential to directly take (kill or harm) sicklefin and sturgeon chubs. Six low-head dam diversion structures are located on the Lower Yellowstone River below Billings, Montana, and five structures are found on the Tongue River, a tributary to the Yellowstone River. Some of the structures are administered and operated by Reclamation, while others are privately owned and operated. Irrigation diversion structures may be located near shallow water habitats for chubs, typically withdraw large volumes of available river flow, and may set up currents that pull or attract fish out of the river and into the diversion canals. Fish become entrained into the diversion canals during the irrigation season, cannot escape, and either die in the irrigated fields or canal after the diversions are completed for the season.

Reclamation (Hiebert et al. 2000) evaluated fish entrainment rates at the intake diversion structure on the Lower Yellowstone River. Studies were conducted during 1996, 1997, and 1998 irrigation by netting 2 to 4 of the 11 unscreened conduits in the diversion structure. Estimates of total entrainment were calculated by extrapolating the monthly average entrainment ratios over the full irrigation season. Reclamation projected that approximately 289,000 ± 113,000 sturgeon chub were entrained during the 3-year study. The projected losses for 1996, 1997, and 1998 were 52,000 ± 39,000, 75,000 ± 18,000, and 163,000 ± 56,000 sturgeon chub.

The diversion dams are generally low-head dams, but effectively act as barriers to upstream migration of native fish that evolved in a low gradient river system. In the late summer, diversions into canals and water withdrawal from the Tongue River may contribute to chronic dewatering of the Tongue River and impacts to the Tongue and Yellowstone fish communities (Backes et al. 1997).

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

No evidence exists that overutilization of the sicklefin chub is occurring for any purpose. Collection of this species occurs at low levels during scientific investigations and for educational purposes. Sicklefin chub are not pursued by fishermen. Though not selectively harvested as a bait species, accidental removal of individual sicklefin chub from the wild may occur during legal harvest of bait fish for personal use throughout most of the chubs' historical range. Accidental removal also could occur from illegal harvest in Tennessee,

Kentucky, and Kansas where sicklefin chub are protected from take. They also could be collected accidentally by legal commercial harvest of bait fish in Montana, North Dakota, South Dakota, Iowa, Missouri, Illinois, Kentucky, Arkansas, Mississippi, and Louisiana. Regardless, regulated collection for scientific and educational purposes, or accidental take associated with personal or commercial harvest of bait fish has a negligible effect on sicklefin chub populations.

C. Disease or Predation.

No studies have been conducted to evaluate the impacts of disease on sicklefin chub. As a result, the significance of this threat is not known, but it is believed to be low. Fishery biologists who collected sicklefin chub during the past 60 years have presented no evidence to suggest that disease presents a threat to sicklefin chub.

The extent of predation on sicklefin chub, both historical and present, is poorly documented. The sturgeon chub and sicklefin chub evolved with a number of piscivorous riverine fishes, including sauger, pallid sturgeon, and channel catfish. Some predation by these species on the sturgeon and sicklefin chub undoubtedly occurred, but the extent is unknown. Since the construction of water resource development projects on the Missouri River and its tributaries, riverine habitat has been lost due to impoundments, and turbidity levels have been reduced significantly in the remaining riverine or stream reaches. These factors, combined with the introduction of other piscivorous fishes more suited to the modified habitat conditions and decreased turbidities, have altered the fish communities and may contribute to the vulnerability of the sturgeon and sicklefin chub to localized predation. The piscivorous walleye (*Stizostedium vitreum*), white bass (*Morone chrysops*), skipjack herring (*Alosa chrysochloris*), and northern pike (*Esox lucius*) either have been introduced to the river systems or have become much greater in abundance in response to changed instream conditions.

Gardner and Berg (1982) reported that sturgeon and sicklefin chub are preyed upon heavily by sauger in the Missouri River in Montana. Sicklefin and sturgeon chub combined were the second most common food item in saugers collected from August to November 1980 in a reach of the river above Fort Peck Reservoir. They were found in 21 percent of the fish collected for stomach analysis. Elser (et al. 1977) evaluated the stomach contents of 43 sauger and 13 burbot (*Lota lota*) collected in the Yellowstone River in 1975 and 1976. Sturgeon chub were found in the stomachs of the sauger (4.7 percent) and one burbot (7.7 percent). Other researchers (Pflieger and Grace 1987) speculated that predation likely has increased over historic levels due to habitat alterations, greater water clarity, and escape of sight feeding piscivores into formerly unoccupied stream habitats. Some local predation is likely to occur at the confluence of tributary streams occupied by chubs and main stem reservoirs occupied by predators.

Sicklefin and sturgeon chub populations evolved with piscivorous fish in the Missouri River Basin and the Mississippi River. The best commercial and biological information available indicates that predation by piscivorous fish is not a threat to the continued existence of the sicklefin and sturgeon chub in locations where turbidity levels and flow conditions are adequate to support their populations.

D. Inadequacy of Existing Regulatory Mechanisms.

The degree or lack of protective classification for the sturgeon chub and sicklefin chub varies widely throughout its range. Several national and State professional conservation societies and environmental departments within various State governments unofficially have classified the sturgeon chub and sicklefin chub as either threatened or endangered, species of special concern, rare, on a watch list, deemed in need of management, or transient. However, these designations do not provide any legal protection to either chub species. Only a few States provide a legal status or regulate protection of the sturgeon chub and sicklefin chub.

Unofficially, the sturgeon chub is classified in Wyoming as a State species of concern and is considered under the State's Mitigation Policy and for planning purposes (Robert Pistono, in litt. 1995; Bill Wichers, in litt. 1997). In Montana, the sturgeon chub and sicklefin chub are considered species of special concern (Hunter 1994). In North Dakota, the Dakota Chapter of the American Fisheries Society (1994) considers the sturgeon chub as threatened and the sicklefin chub as endangered. In Nebraska, both the sturgeon chub and sicklefin chub are considered species of special concern (Ross Lock, Nebraska Game and Parks Commission, pers. comm. 1995). The species have not been classified in Iowa (Daryl Howell, Iowa Department of Natural Resources, pers. comm. 1995). The sturgeon chub and sicklefin chub are considered rare in Missouri (Missouri Department of Conservation 1995).

In South Dakota, the sturgeon chub and sicklefin chub officially are classified as threatened (Eileen Dowd Stukel, South Dakota Department of Game, Fish, and Parks, in litt. 1997). However, the South Dakota Department of Game, Fish, and Parks believes the sicklefin chub may be extirpated from the State (Douglas Hofer, in litt. 1995). Both chubs receive legal protection in the State of Kansas where the sturgeon chub and sicklefin chub are classified officially as threatened and endangered, respectively. Take of either species is prohibited and provisions allow for habitat protection and designation of critical habitat (Kansas Department of Wildlife and Parks 1992). The sturgeon chub is listed as endangered in the State of Illinois. The State prohibits the take of the sturgeon chub and provides some habitat protection (Sue Lauzon, pers. comm. 1995, and in litt. 1997). Kentucky has restrictions on collections of both chubs (Wayne Davis, Kentucky Department of Fish and Wildlife Resources, pers. comm. 1995) and Tennessee prohibits the take or possession of either chub, or the knowing destruction of habitats (Bob Hatcher, Tennessee Wildlife Resource Commission, pers. comm. 1995). In Louisiana, neither species is protected on a "State List." The Louisiana Department of Wildlife and Fisheries considers sicklefin and sturgeon chub as

transient species (John Roussel, Louisiana Department of Wildlife and Fisheries, in litt 2000). In light of the low numbers of sturgeon chub and sicklefin chub in these States, the effectiveness of the various regulations is difficult to assess.

Missouri River Bank Stabilization and Navigation Project - Fish and Wildlife Mitigation: Congress authorized mitigation for fish and wildlife resources lost due to the construction, operation, and maintenance of the BSNP, within the States of Missouri, Kansas, Iowa, and Nebraska, in Section 601(a) of the Water Resources Development Act of 1986 (WRDA 86, Public Law 99-662). The Corps supported that authorization with the April 24, 1984, Chief of Engineers' report, "Missouri River Fish and Wildlife Mitigation, Iowa, Nebraska, Kansas, and Missouri." That report, based on a May 1981 Feasibility Report and Environmental Impact Statement completed by the Missouri River Division, documented the estimated loss of 522,000 ac (211,410 ha) of aquatic and terrestrial habitat in and along the Missouri River between 1912 and 2003 attributable to the BSNP. Based on those losses, the 1984 report also described various measures to compensate for these losses and recommended a plan to restore, preserve, or develop 48,100 ac (19,480 ha) of land (U.S. Army Corps of Engineers 1984). Project construction is to include land acquisition and habitat development on 29,900 ac (12,109 ha) of land and habitat development on 18,200 ac (7,371 ha) of existing public lands within the four affected States. Although several mitigation alternatives were proposed, the selected alternative, when fully implemented, would compensate only an estimated 3 percent of lost aquatic acres and 7 percent of lost terrestrial acres attributable to the BSNP. Like the BSNP, the Mitigation Project is completely federally funded (i.e., construction, operation, and maintenance).

If fully implemented, the Mitigation Project will preserve and restore 3,200 ac (1,296 ha) of aquatic habitat, and 44,900 ac (18,184 ha) of terrestrial habitat through development of habitat on public lands and acquisition and development on private lands. Funding began in Fiscal Year 1992. As of April 2000, approximately 79 percent of the originally authorized land acquisition acreage has been acquired (23,549 ac out of 29,900 ac originally authorized). Land acquisition is complete in Kansas and Nebraska, and is likely to be completed in Iowa and Missouri in the next couple of years. Of these acquired lands, approximately 18 percent (4,295 ac [1,739 ha]) have been developed for fish and wildlife. Habitat development of public lands as of April 2000, is 2,504 ac (1,014 ha) of the 18,200 ac (7,371 ha) authorized, or about 14 percent.

Conceptual aquatic habitat objectives for mitigation sites call for reclaiming and reconnecting filled-in chutes and backwaters, and preventing future sedimentation. Terrestrial habitat development will depend on the existing habitats types, and for public land, existing management objectives. Habitat development may involve dredging of filled-in wetlands, enlarging wetlands, side channel openings/closure, bank stabilization, dike and levee construction, pumping, reforestation, timber stand improvement, food plot establishment and native re-vegetation. Restoration of floodplain habitats such as mature bottomland forests

will take many years before significant habitat benefits will begin to accrue to the Missouri River ecosystem. Restoration of other habitats like emergent wetlands, shallow water areas, and chutes should result in more immediate benefits to the river ecosystem.

On most existing public lands, terrestrial habitats are likely to remain isolated from the river by levees. On acquired lands, the value of the Mitigation Project to the riverine environment will depend on its potential for restoring main channel and off-channel habitat, and reconnecting floodplain habitats to the river during the spring flood pulse. Areas with extensive levee protection and no connected aquatic and wetland habitats such as chutes, sloughs, side channels, or temporary and seasonal wetlands will have less value to the riverine/floodplain ecosystem.

Recently, Section 334 of the WRDA of 1999 reauthorizes the Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project and increases the amount of lands, and interests in land, to be acquired for the project by 118,650 ac (48,053 ha). To determine the cost of this project modification, Section 334 (b)(1) also directs the Corps to conduct a study within 180 days in conjunction with the States of Nebraska, Iowa, Kansas, and Missouri. That report was completed in April 2000. The Corps is awaiting congressional action to implement the expanded mitigation project.

Based on conceptual plans for restoration projects in the four States, the agencies anticipate the expanded project could potentially provide approximately 7,000 ac (2,835 ha) of shallow water, sandbar habitat (under existing hydrologic conditions) which will benefit native fish populations including sicklefin and sturgeon chub. Monitoring programs to evaluate fish populations are needed to quantify benefits of project-related shallow water, sandbar habitat to the listed and candidate endangered species. The expanded mitigation project also is expected to provide approximately 20,000 ac (8,100 ha) of additional wetland habitat and 92,000 ac (37,260 ha) of additional terrestrial habitat in the Missouri River floodplain.

Preliminary monitoring data for selected mitigation and control sites in Nebraska and Missouri are currently available. The Nebraska Game and Park Commission has initiated a monitoring program at chute restoration, backwater, and dike modification/removal mitigation sites and at control sites in the Missouri River. In the spring of 1999, three sturgeon chub were collected with seines at the Hamburg Bend mitigation site. Benthic trawl samples were taken at the Tobacco Island mitigation site and the Goose Island control site during the fall of 1999. Five sturgeon chubs were collected from the Tobacco Island area, representing 23 percent of all sturgeon chub collected in the Nebraska reach of the Missouri River since 1941. One sicklefin chub was taken at Goose Island. This was the first sicklefin chub collected in the Nebraska reach of the Missouri River since 1988 (Nebraska Game and Park Commission 2000). Nebraska Game and Park Commission will continue its monitoring efforts in the coming year to evaluate the Missouri River BSNP - Fish and Wildlife Mitigation Project.

In Missouri, the Service sampled a 7-mile reach of the Lower Missouri River around the Jameson Island (River Mile 219) and Lisbon Chute (River Mile 217) mitigation areas using a benthic trawl, mini-fyke nets, and seine. During the period from 1997 to 1999, 480 sicklefin chub and 13 sturgeon chub were collected (Louise Mauldin, U.S. Fish and Wildlife Service in litt. 2000). Work conducted by the University of Missouri between 1994 and 1997 documented the use of scour holes by sicklefin and sturgeon chub and their high value as nursery habitat for larval, juvenile and young-of-year fish (John Kubisiak, Missouri Cooperative Fish and Wildlife Research Unit, in litt. 1997; John Tibbs, Missouri Cooperative Fish and Wildlife Research Unit, in litt. 1997; Doug Dieterman, Missouri Cooperative Fish and Wildlife Research Unit, in litt. 1999).

E. Other Natural or Manmade Factors.

Hybridization: Fishery biologists have noted the presence of a small percentage of chub hybrids in collections from the Missouri River in Missouri. Grace and Pflieger (1985) collected one speckled chub x sturgeon chub and one sturgeon chub x sicklefin chub in a sample of 18,400 fish collected near Easley, Missouri (river mile 177.3 to 169.9) in 1982 and 1983. Gelwicks et al. (1996) reported 18 speckled chub x sturgeon chub hybrids in collections made in 1994. The hybrids were found at 7 of 13 collection sites in the Missouri River, from the Iowa-Missouri border in the confluence of the Missouri and Mississippi Rivers near St. Louis. Hybridization has not been reported at other locations within the range of the sicklefin and sturgeon chub. While the extent of hybridization and potential impacts to sicklefin and sturgeon chub populations appears to be minor at this time, future studies should monitor and report on the presence of hybrids.

Pollution/Contaminants: Although it does not appear that pollution has directly contributed to reduction of the species range, pollution may be an exacerbating threat. Pollution of the Missouri River by organic wastes from towns, packing houses, and stockyards was evident by the early 1900s and continued to increase as populations grew and additional industries were established along the river (Whitley and Campbell 1974). Due to the presence of a variety of pollutants, numerous fish-harvest and consumption advisories have been issued over the last decade or two from Kansas City, Missouri, to the mouth of the Mississippi River.

Riverine habitats important to sicklefin and sturgeon chub are subject to acute and chronic water quality impacts and contamination associated with oil development and transport of crude oil products. In the past 10 years, oil pipelines crossing the lower reaches of the Chariton River and Gasconade River, two major tributaries of the Missouri River in Missouri, have ruptured and spilled large amounts of crude oil, which eventually reached the main stem. In June 1995, an oil spill that occurred into an irrigation canal near the confluence reached the Missouri River. Barge accidents have occurred on the Mississippi River and resulted in the release of contaminants. Because of the volume of flow and dilution factor in the Yellowstone, Missouri, and Mississippi Rivers, the potential for oil spills and release of other contaminants to impact large areas of sturgeon and sicklefin chub

habitat is considered low, and direct impacts to chubs minor. State and Federal agencies have programs in place to address spills of oil and other contaminants. These programs minimize any impacts that a spill might have on habitat for fish and wildlife. For example, the State of Missouri's Department of Natural Resources and the Environmental Protection Agency oversee cleanup activities related to oil spills. We also work with our partners to minimize impacts of spills on fish and wildlife.

Invasive Species: Impacts to native fish and wildlife populations is ever increasing due to the introduction of non-native species that have the capacity to cause irreparable damage. A major contributor to the depletion and extinction of native species, second only to habitat loss, is the introduction of species into new environments. The threats to native populations include--displacement of native species through competition for habitat or forage, decreasing the amount of biological diversity necessary to maintain a viable native population, impacting water quality, reducing habitat quality for native populations and influencing the biomass of fragile populations.

In the Missouri River below Gavins Point Dam, these effects are currently happening at an ever increasing rate. Exotic fish species have entered the Missouri River via the Mississippi River and are expanding upstream into suitable habitats. A number of Asian carp species are currently established in this section of the river. These include the bighead, black, silvery, and grass carp. Changes to Missouri River fish populations seem to be occurring already. Anecdotal information from commercial anglers indicates that Asian carp have become a dominant by-catch and are actually replacing desired species. Currently, no data exist to document that chubs are being impacted directly by invasive species. However, if Asian carp populations continue to expand, the diversity of species supported by the Missouri and Mississippi River ecosystems, including chubs, will likely be negatively impacted.

In the Missouri River basin above Gavins Point Dam, a potential also exists for undesirable exotic species to impact fish populations, although this threat has not occurred to date. Eventually, some exotic species likely will be introduced. Introduction of exotic invasive species has the potential to impact native populations, such as the two chub species, through direct and indirect competition with aquatic plants and animals, thereby decreasing available habitat.

Impingement: The Service (1993a, 1993b), Stasiak (1990), and Hesse et al. (1982) reported the impingement of very low numbers of both sicklefin chub and sturgeon chub at once-through-cooled power plant intakes on the Missouri River in Nebraska. Between 1973 and 1977, one sicklefin chub and two sturgeon chub were impinged at the Fort Calhoun Nuclear Station (river mile 646). Impingement sampling frequency at Fort Calhoun was twice daily from May through September, and once daily from October through April. At Cooper Nuclear Station (river mile 556) only one sturgeon chub was reported impinged between 1974 and 1977, with five randomly selected diurnal and nocturnal sampling times per week. Only two sicklefin chub and one sturgeon chub were impinged at the

Iatan Power Plant intake (river mile 411), another once-through-cooled plant, in northwest Missouri during 12, 24-hour surveys between October 5 and December 31, 1980 (Geo-Marine, Inc. 1981). The water withdrawal rate during the Iatan study was about 550 cubic-feet-per-second, or roughly 1 to 2 percent of the river flow. A 4-year study of power plant impingement, entrainment, and water temperature effects to Middle Missouri River adult fish communities did not detect changes in the adult fish populations because of power plant operations. Overall impacts to the river's aquatic communities were considered minimal (Hesse et al. 1982).

Impingement and entrainment impacts to chub populations from municipal and industrial water intakes throughout the species' ranges are unknown due to lack of data. Compared to once-through-cooled power plants, these intakes withdraw insignificant amounts of water in comparison to river flow, especially those along the main stem Missouri and Mississippi Rivers. However, power plant, municipal, industrial, and irrigation intakes sited in river segments with less altered habitats, such as occur in the Upper Missouri and Yellowstone Rivers in Montana and upper basin tributaries, have greater potential to impinge and/or entrain chubs.

Quantifiable power plant, municipal, and industrial intake threats to chubs along the Lower Missouri River in Missouri and the Middle Mississippi and Lower Mississippi Rivers are unknown due to the lack of data. The larger populations of both species in the Missouri River below Kansas City increases the probability that intakes, especially those at once-through-cooled power plants that remove higher percentages of the river flow, accidentally will take individuals of both species.

XI. SUMMARY OF FACTORS AND THREATS AFFECTING STURGEON CHUB

A. The Present or Threatened Destruction, Modification, or Curtailment of the Species' Habitat or Range. Issues for the sturgeon chub are the same as previously described for the sicklefin chub.

Please see sicklefin chub summary, page 51.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

No evidence exists that overutilization of the sturgeon chub is occurring for any purpose. Collection of this species occurs during scientific investigations and for educational purposes. They are not pursued by fishermen. Though not selectively harvested as a bait species, accidental removal of individual sturgeon chub from the wild may occur during legal harvest of bait fish for personal use throughout most of the chubs' historical range. Accidental removal also could occur from illegal harvest in Tennessee, Kentucky, Kansas, and Illinois, where sturgeon chub are protected from take. They also could be collected accidentally by legal commercial harvest of bait fish in Montana, North Dakota, South Dakota, Nebraska, Iowa, Missouri, Kentucky, Arkansas, Mississippi, and Louisiana. Regardless, regulated collection for scientific and educational purposes, or accidental take associated with personal

or commercial harvest of bait fish has a negligible effect on sturgeon chub populations.

C. Disease or Predation. Issues for the sturgeon chub are the same as previously described for the sicklefin chub. Please see sicklefin chub summary, page 55.

D. Inadequacy of Existing Regulatory Mechanisms. Issues for the sturgeon chub are the same as previously described for the sicklefin chub. Please see sicklefin chub summary Page 55.

E. Other Natural or Manmade Mechanisms.

Drought: Severe drought, combined with the construction of the Missouri River main stem dams and reservoirs, may be a factor influencing sturgeon chub populations in some tributaries. Historically, the impacts of severe drought on sturgeon chub populations in tributary streams was likely mitigated by refugia habitat offered by the Missouri River. Prior to impoundment, the Missouri River provided habitat to sustain populations during severe drought and a source of chubs to recolonize tributaries following drought. Today, approximately 750 miles of refugia habitat, from the headwaters of Lake Sakakawea to Gavins Point Dam, has been degraded or converted to reservoir habitat and no longer provides suitable habitat to sustain sturgeon chub populations.

For example, severe drought in the Missouri River basin in the late 1980s and early 1990s may have contributed to the extirpation of sturgeon chub from the Little Missouri River in North Dakota and South Dakota. Kelsch (1994) sampled a number of sites in the Little Missouri River where Reigh and Elsen (1979) had collected sturgeon chub in 1976 and 1977; however, Kelsch did not collect sturgeon chub. He hypothesized that the closure of the Garrison Dam in 1953 and the subsequent formation of Lake Sakakawea eliminated the Missouri River as refugia habitat for sturgeon chub during periods of severe, prolonged drought. During prolonged drought, which occurred in the region of the Little Missouri River between 1987 and 1993, sturgeon chub may have been unable to persist in the Little Missouri River during periods of intermittent flow, clearing water, and silty substrate conditions that periodically occurred. During historic periods of severe drought, the unimpounded Missouri River may have served as a refuge, continuously providing turbid, flowing conditions necessary for sturgeon chub survival.

Due to fragmentation of habitats, tributaries like the Little Missouri River that flow into reservoirs are now isolated from riverine habitat with sturgeon chub, therefore preventing natural recolonization from downstream riverine reaches. These isolated streams may need to be augmented and stocked with chubs captured from other stable populations (Dryer et al. 1997). However, the introduced populations, if successful, will be subject to the same impacts during the next protracted drought.

Sturgeon chub populations evolved with periods of extended drought as a natural factor

influencing their habitat. While construction of the dams on the Missouri River coupled with drought may have resulted in the loss of sturgeon chub populations in some tributaries, we do not believe this is a significant factor affecting existing populations.

Coalbed Methane Production: Coalbed methane development in northeastern Wyoming and southeastern Montana poses a potential threat to sturgeon chub populations and habitat in the Powder and Tongue River basins (David Felley, U.S. Fish and Wildlife Service, Cheyenne, Wyoming, pers. comm. 2000, and Lou Hanebury, Fish and Wildlife Service, Billings, Montana, pers. comm. 2000). Methane locked in coal beds is extracted by using modified water well drilling rigs to establish wells and then pumping water out of the formation to reduce the hydrostatic pressure. Wells typically produce mostly water at first (12-15 gallons per minute), but over time the amount of water declines and gas production increased as the bed is dewatered. The water is either discharged on the surface or injected into underground aquifiers. At this point, studies have not been conducted to determine infiltration and evaporation losses or the amount of discharge water reaching the Powder River.

Coalbed methane production in Wyoming is a rapidly expanding industry. In the Powder River basin, approximately 3,000 active wells exist and over 11,000 additional wells have been permitted for drilling. Industry estimates indicate that up to 75,000 wells are possible over the next 60 years in the Powder River Basin. In Montana, coalbed methane production has occurred to a limited degree, with approximately 170 wells currently producing. The Montana Department of Environmental Quality has placed a moratorium on the permitting of new wells until an environmental impact study is complete.

Coalbed-methane-produced water that meets Wyoming water quality standards is typically discharged into intermittent drainages and surface waters. The Wyoming Department of Environmental Quality initially thought the existing standards concerning water produced during oil and gas production were adequate; however, given the magnitude of rapid expansion of coalbed methane production, this position is being reviewed (Wyoming State Engineer's Office, State Water Forum Meeting, October 27, 2000).

Potential water quality issues associated with the production of coalbed methane have been identified by the Service's Cheyenne, Wyoming, Field Office. Groundwater samples taken from Powder River basin coal seams have trace element concentrations exceeding the aquatic chronic criteria for arsenic, cadmium, copper, iron, lead, selenium, and zinc. Coalbed-methane-produced water in the Powder River drainage is generally higher in sodium and total dissolved solids and has a higher sodium adsorption ratio than water produced at methane wells in the Belle Fourche drainage. The Service is collecting water discharged at producing wells to evaluate trace element concentrations and assess potential impacts to fish and wildlife resources.

Coalbed methane production has the potential to impact sturgeon chub populations in the

Powder and Tongue Rivers drainages; however, at this time sufficient information is not available to determine the significance of this threat. Field studies evaluating discharges throughout the year are needed to document water quantity and quality effects and their significance to fish and wildlife resources.

Yellowstone River Basin Low Head Dams: The lowhead dams on the Yellowstone River and its tributaries have been identified as being barriers to native fish species which migrate for spawning purposes. Normally, these lowhead dams also are associated with a water withdrawal system for irrigation or municipal water uses which subsequently entrain fish species, thereby affecting recruitment and survival to the populations.

Reclamation's lowhead dam located at Intake, Montana, has been identified as a structure to be privatized and transferred to the Lower Yellowstone Irrigation District. As part of this transfer, the Service and Reclamation entered into a formal consultation under the ESA. Effects of this structure were identified for the pallid sturgeon, as well as for the sturgeon chub. Reclamation decided to incorporate "fish friendly" changes into the structure as part of the transfer process. Due to uncertainties in the actual design changes needed to be effective for pallid sturgeon, Reclamation has decided to identify that changes are needed and convene experts in fish passage and sturgeon to develop an alternative that will best suit this situation. Reduction of entrainment losses at Intake is expected to be very beneficial to sturgeon chubs.

Several other structures on the Yellowstone and its tributaries above Intake may offer opportunities in the future to make improvements for fish passage and reduce entrainment losses. Improvements at any of these sites could benefit the chubs.

XII. ONGOING REGULATORY AND CONSERVATION ACTIONS

Missouri River Biological Opinion: In November of 2000, the Service completed a biological opinion (U.S. Fish and Wildlife Service, 2000) under Section 7 of the ESA on the Corps' Operation of the Missouri River Main Stem System, the related operation of the Kansas River Tributary Reservoirs, and the Operations and Maintenance of the Missouri River Bank Stabilization and Navigation Project. The habitat covered in this consultation includes the Missouri River from the headwaters of Fort Peck Reservoir to its confluence with the Mississippi River at St. Louis. Among the four species covered in this consultation is the pallid sturgeon. The pallid sturgeon inhabits large, turbid rivers and in much of its range, the pallid sturgeon uses habitats similar to the sicklefin and sturgeon chub.

The Service found that to avoid jeopardizing the continued existence of the pallid sturgeon, restoration of a portion of suitable riverine and aquatic habitat, and hydrologic conditions on river segments between Fort Peck and the headwaters of Lake Sakakawea, and the river below Gavins Point Dam to its confluence with the Mississippi is necessary. As part of the consultation, the Service developed a Reasonable and Prudent Alternative (RPA) that includes actions for the pallid sturgeon and the ecosystem in general. The alternative is designed to return

some semblance of practical "form and function" of a river system to appropriate sections of the Missouri and Kansas Rivers. This alternative, in part, includes flow enhancement, temperature modifications, and habitat restoration/creation in key sections of the river.

An integral part of this process is adopting an adaptive management approach. Adaptive management allows regular modification of management actions based on new information from the endangered species and habitat monitoring program and changing environmental conditions. An agency coordination team will guide development and implementation of future river management and habitat development activities. The Corps is currently working on an Implementation Plan for the RPA. When all or parts of this RPA are implemented, the Service expects a beneficial impact to the ecology of the river and, in particular, its indigenous species, including sicklefin and sturgeon chub populations.

The current emphasis on the Missouri River is to restore enough environmental integrity to the river to avoid jeopardizing its species. This emphasis, if implemented, is expected to have a significant beneficial effect on both the chubs through habitat restorations/creations, improved temperature regimes, and beneficial and stimulating flow modifications in sections of river above Lake Sakakawea and below Gavins Point Dam.

Little Missouri River Sturgeon Chub Reintroduction: In 1997, the Service developed a reintroduction plan to re-establish extirpated populations of the sturgeon chub in the Little Missouri River (Dryer et al. 1997). Through a partnership with the North Dakota Game and Fish Department, the Montana Department of Fish, Wildlife, and Parks, National Park Service, U.S. Forest Service, and Reclamation, sturgeon chub have been captured at or near the Intake Diversion Structure on the Lower Yellowstone River in Montana during the past three field seasons. This work resulted in releasing 302, 473, and 201 sturgeon chub into the Little Missouri River at the South Unit of Theodore Roosevelt National Park in 1998, 1999, and 2000, respectively (U.S. Fish and Wildlife Service 1998 and Wade King, Fish and Wildlife Service, pers. comm. 2000). Test netting conducted in the Little Missouri River after reintroduction has yielded no sturgeon chub. The Service is currently evaluating this initiative. Sturgeon chub collected at the Intake Diversion Structure also have been provided to Gavins Point National Fish Hatchery and the Bozeman Fish Technology Center to develop propagation techniques.

XIII. FINDINGS AND CONCLUSIONS

The Service has compiled and analyzed the available data on sicklefin and sturgeon chub populations throughout their range. We found that sicklefin and sturgeon chub are highly adapted for conditions found in turbid, free-flowing river systems. The historic range of the sicklefin chub included the Lower Yellowstone River, the Missouri River, and the Mississippi River below the confluence with the Missouri River. The range of the sturgeon chub overlapped the sicklefin chub and included 30 tributaries to the Yellowstone and Missouri Rivers. Sturgeon chub also ascended further upstream in the Yellowstone and Missouri Rivers than sicklefin chubs. We also found the literature documenting sicklefin and sturgeon chub provide an

incomplete picture of population levels, range, habitat use, and biology. Information documenting chub baseline conditions (prior to the construction on the Missouri River main stem dams) is limited to a few records documenting the presence of these species.

In 1993, the Service issued status reports for the sicklefin chub and sturgeon chub. The reports indicated the range and populations of sicklefin and sturgeon chub have been substantially reduced. In August 1994, the Service was petitioned to list the sicklefin and sturgeon chub as endangered. These actions helped to focus attention on two species that had been largely overlooked throughout much of their range. While major information gaps remain concerning feeding habits, reproduction, seasonal habitat use, and other aspects of sicklefin and sturgeon chub biology, substantially greater emphasis has been placed on documenting chub populations and their habitats during the past 7 years.

At the same time as the petition to list the sicklefin and sturgeon chub as endangered was filed, fishery biologists modified the gear used to sample cyprinid populations. Until 1993, researchers primarily relied on seines to collect small fish in the Missouri and Mississippi Rivers. Seines allowed sampling in shallow water sandbar and border channel habitats, usually not exceeding 1.5 m (4.9 ft) in depth. Grisak (1996) was the first to use a benthic trawl, modified to catch small fish, to characterize the fish population in the Missouri River. Grisak's work above Fort Peck Reservoir in Montana during 1994 and 1995 and the results of subsequent field investigations using benthic trawls have provided new information on the range and relative abundance of the sicklefin and sturgeon chub. He collected 5,095 fish, using seines to sample shallow-water sites (0.19 to 0.86 m - 0.6 to 2.8 ft). Sicklefin and sturgeon chub were rare in seine hauls, comprising 0.08 and 0.16 percent of the total catch, respectively. Sturgeon chub ranked 14th in abundance and sicklefin chub ranked 15th in seine hauls. In comparison, Grisak collected 302 sicklefin chub (21.9 percent of the catch) and 260 sturgeon chub (18.9 percent of the catch) using a benthic trawl. Sicklefin and sturgeon chub were the second and third most common species collected in benthic trawl tows. The mean depth at trawl sites where sicklefin chubs were collected was 3.41 meters.

Field studies, conducted since the 1993 status reports were issued, indicate that sicklefin chub and sturgeon chub are more widespread and occur in greater numbers than previously believed. Researchers in Montana (Gardner 2000a,b), North Dakota (Liebelt, in litt. 1999, Everett 1999, Welker 2000), and Missouri (Grady and Milligan 1998, Hrabik and Herzog, in litt. 2000a,b) have collected substantially greater numbers of sicklefin and sturgeon chub using trawling techniques. Recently, new locations supporting sicklefin and sturgeon chub populations, such as the Wolf Island area of the Lower Mississippi River also have been identified.

While recent studies documenting sicklefin and sturgeon chub populations are encouraging, the range of these species has been substantially reduced. The major factors impacting sicklefin and sturgeon chub populations are the construction and continued operation of the six main stem dams on the Missouri River built as part of the Pick Sloan Plan between 1937 and 1964, the loss of habitat associated with the Bank Stabilization and Navigation Project in the Middle and Lower

Missouri River, and navigation projects on the Middle and Lower Mississippi River. The dams altered the physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity, and nutrient input that provided habitat for sicklefin chub, sturgeon chub, and other native fish species. Today, approximately 36 percent of the Missouri River's riverine habitat has been converted to reservoirs, 40 percent has been channelized, and the remaining 24 percent has been altered by changes in water temperature, turbidity levels, and flow conditions caused by dam operations. Sicklefin chub currently occupy approximately 54 percent of its historic range in the Missouri River basin. Sturgeon chub are currently found in about 55 percent of its former range in the Missouri River. Sturgeon chub also occur in 11 of the 30 tributaries to the Yellowstone and Missouri Rivers where historic catch records exist.

Sicklefin and sturgeon chub populations have been eliminated from over 800 miles of the Missouri River that has been impounded, and approximately 200 miles of inter-reservoir reaches between Garrison Dam in North Dakota and Gavins Point Dam in South Dakota. These species also are found in low numbers in the Middle Missouri River, below Gavins Point Dam to St. Joseph, Missouri. Collectively, the results of field investigations indicate viable, self-sustaining populations of sicklefin and sturgeon chub continue to occur in a portion of their historic range, while in other areas these species have been extirpated or exist in low numbers.

The ESA defines a threatened species as any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. An endangered species is defined as any species which is in danger of extinction throughout all or a significant portion of its range. A species may be determined to be threatened or endangered due to one or more of five factors described in Section 4(a)(1) of the ESA. The decision concerning whether a species warrants listing requires an evaluation of past actions and measures in the foreseeable future that affect the species.

As discussed previously, the principal factor impacting sicklefin and sturgeon chub populations is the construction and operation of the dams on the main stem Missouri River, operation and maintenance of the Bank Stabilization and Navigation Project in the Missouri River, and the navigation channel on the Mississippi River. Water depletion projects, impoundments, entrainment, and drought impacted sturgeon chub populations in the Yellowstone River and tributaries to the Yellowstone and Missouri Rivers. The threats posed by the dams and reservoirs have been in place for over 35 years. Despite the loss of over 1,000 miles of suitable habitat in the Missouri River, sicklefin and sturgeon chubs continue to be found in good numbers where habitat conditions, flow patterns, and turbidity levels resemble conditions prior to the construction of the main stem dams. Likewise, the wide-spread extant chub populations provide evidence that these species retain viable populations in spite of impacts of water depletions, entrainment and drought.

Sicklefin and sturgeon chub are short-lived species, with a small percentage of their populations reaching age 4+. While little is known about sicklefin and sturgeon chub reproduction, these species have successfully propagated with the major identified threats in place since 1964, when the Big Bend Dam in South Dakota, the last major flood control component of the Pick-Sloan Plan, was completed. Sicklefin and sturgeon chub have successfully reproduced under a variety of flow conditions in the Missouri River, including periods of extended drought and persistent high water levels.

There are potential impacts associated with coalbed methane production in Wyoming and Montana, future water impoundment and depletion projects on the Yellowstone River, its tributaries, and tributaries to the Missouri River, and Asian carp population in the Lower Missouri and Mississippi Rivers. However, based on the information currently available, we do not believe that magnitude of these threats are sufficient to endanger the population viability of these species throughout their range.

On the basis of the available information, the Service concludes that neither the sicklefin chub nor the sturgeon chub are likely to become threatened or endangered in the foreseeable future. Stable, self-sustaining populations of sicklefin and sturgeon chub exist in widely scattered areas of their range. Chub populations continue to successfully reproduce with principal factors impacting chub habitat, the Missouri River main stem dams having been in place for over 35 years. Therefore, listing the species is not currently warranted. This conclusion is based on the best available information summarized in this document.

Our not warranted finding is based on the current status of these species, and upon our analysis of such future threats that are known at this time. The Service is encouraged that ongoing and planned conservation measures will benefit sicklefin and sturgeon chubs and their habitats in the foreseeable future. As discussed previously, these projects include the Missouri River BSNP Fish and Wildlife Mitigation Plan, conservation measures identified in the Missouri River Biological Opinion, and section 7 consultation to minimize fish entrainment at the intake diversion structure in the Yellowstone River. The Service believes that the identified conservation measures provide priority actions to improve habitat conditions for sicklefin and sturgeon chub.

The Service recommends that Federal and State natural resource agencies, tribal groups, universities, conservation organizations, and other concerned entities continue to monitor, protect, and restore sicklefin and sturgeon chub populations throughout their range. Information in the literature describing the feeding habits, reproduction, seasonal habitat use, predator prey relations, and other aspects of sicklefin and sturgeon chub biology is limited. To protect and enhance sicklefin and sturgeon chub populations and their habitat, additional research and monitoring is needed to guide habitat rehabilitation plans and reintroduction efforts.

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